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Field Crop Recommendations

Ministry of
Agriculture
and Food

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SOILS
CEREALS
BEANS AND PEAS
CANOLA RAPESEED
PESTICIDES

87-04756/

To the best of the collective knowledge of the members of the Ontario Crop Protection Committee, all pesticides listed in this publication were federally registered, reviewed by the Ontario Pesticides Advisory Committee and classified by the Ministry of the Environment as of November 13, 1986.

The information presented on the pesticide container label regarding application rates and methods of application are the final authority and where conflicts occur between this publication and the container label, the latter applies.

PAY CLOSE ATTENTION TO ALL INSTRUCTIONS AND WARNINGS PRINTED ON THE PESTICIDE LABEL.

The Ministry of Agriculture and Food, or the Ontario Crop Protection Committee by printing this publication does not offer any warranty or guarantee and they do not assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

POLICY STATEMENT

In this publication, most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that, in some cases, the most effective pesticides are highly toxic.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powders (WP or SP) generally are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

A number of brand names of pesticides are given in the calendars as a convenience to the grower and are neither an endorsement of the product nor a suggestion that similar products are not effective.

The pesticide recommendations are reviewed annually by the Ontario Crop Protection Committee. **OLD EDITIONS SHOULD BE DISCARDED.**

For additional information or clarification of recommendations, contact Ontario Ministry of Agriculture and Food personnel listed on page 72.

FEDERAL REGISTRATION AND PROVINCIAL CLASSIFICATION

Ontario's Pesticides Act and Regulations 751, administered by the Ministry of the Environment, prohibits the sale and use of pesticide products unless they are registered under the federal Pest Control Products Act and classified under the provincial Pesticides Act by being placed in one of six schedules of the Ontario regulation.

FEDERAL REGISTRATION

There are three categories:

1. **Full Registration**

   Implies that all federal departments involved in the registration process agree that the data package was acceptable at the time of registration.

2. **Temporary Registration**

   Indicates that there is a need for additional scientific or technical information to acquire a full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use in the following year.

3. **Temporary Registration (Restricted Class)**

   Indicates that there is an urgent need for the pesticide but that studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use the following year. The pesticide product presently carrying a temporary registration (restricted class), classified for use in Ontario and included in this publication is Bayleton (triadimefon). This material may, or may not, be available for use in 1987.

PROVINCIAL CLASSIFICATION

Pesticide products are classified into six schedules in Regulation 751 on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration and usage. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario.

A procedure has recently been put in place to upgrade the classification process for pesticide products. This procedure provides for "interim status" products. These products are proposed by the Minister for inclusion in a schedule to Regulation 751, and the proposal is published in the *Ontario Gazette*. A person who sells or uses such a product as if it were in the specified schedule, is exempt from the prohibition against sale or use of an unscheduled product.

For updated information on the regulatory status of these or other pesticides contact the Agriculture & Industrial Chemicals Section, Hazardous Contaminants & Standards Coordination Branch, Ministry of the Environment, Toronto Telephone (416) 965-2401.

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SOIL MANAGEMENT AND FERTILIZER USE

Ontario currently uses about 1,000,000 tonnes of fertilizers annually. High yields can be produced efficiently only when fertilizer use is related to the fertility level of the soil and to other additions of nutrients in manure, crop residues, etc. At one extreme, on very low fertility soils, it is occasionally profitable to add as much or more nitrogen, phosphorus, or potassium in the fertilizer as a crop removes. At the other extreme, on high fertility soils or following heavy application of manures, fertilizer may not be profitable and occasionally may reduce yields.

SOIL TESTING

Why Soil Test?

Soil testing is currently by far the most accurate tool available to Ontario farmers to determine the amounts of phosphorus, potassium and magnesium fertilizers and lime which should be applied to field crops.

Other Methods of Assessing Nutrient Needs

1. Plant analysis is the main tool used for tree fruits and can serve as additional information supporting the soil test for field and vegetable crops.
2. Nutrient deficiency symptoms on crop leaves are helpful in some cases but have serious drawbacks in others, particularly with potassium and phosphorus.
3. It is occasionally suggested that a farmer apply the amounts of nutrients removed by the crop. This has some application for nitrogen, as with some crops the suggested rate approximates what the plant removes. It has little relevance for other nutrients in Ontario. Many of our clay and clay loam soils have sufficient potassium to last for many years and application of potassium each year on those soils is a waste of money and ignores one of the few advantages which clay soils have over coarser - textured soils.

The soil testing program is the main guide along with help from plant analysis and nutrient deficiency symptoms to determine your fertilizer requirements for a specific crop on a specific field.

What does the OMAF Soil Testing Program Provide for the Farmer?

The soil testing program provides recommendations for nitrogen, phosphate, potash and magnesium fertilizer along with recommendations for the amount and type of lime you should apply. These recommendations are expected to produce maximum profits under recommended management methods. Some fertilizer is recommended at soil test levels slightly above those where crop response is profitable. This is done to maintain high soil nutrient levels, and to allow for some error in sampling the field. For high value crops such as tobacco the maximum profit we aim for will require essentially the same amount of fertilizer as maximum crop value (maximum yield with high quality). For low value crops such as oats there may on occasion be a slight yield response to rates of fertilizer above those recommended for maximum profit. However, trials on farm fields with corn have shown no yield response to rates of fertilizer above those recommended by soil test. *Further assistance in interpreting soil test reports* is available from the County and District agricultural offices of the Ontario Ministry of Agriculture and Food.

Soil Tests from Other Laboratories

Each year a number of farmers ask OMAF staff to interpret soil test results from other laboratories. Provided the other laboratory uses the identical chemical tests used for the OMAF service and expresses their test results in the same units, the OMAF fertilizer requirements for phosphate and potash can be applied. However, it is rare that this is the case.

Only soil tests using chemical extractants which have been calibrated by a number of field experiments on Ontario soils can be relied on to provide accurate fertilizer recommendations. Be certain that the service you are using measures up to these standards.

A number of laboratories provide tests such as exchange capacity, aluminum and copper not provided through the OMAF services. These are not provided by the OMAF service because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils use of exchange capacity to adjust potash recommendations can lead to less reliable recommendations than are now provided.

Soil Sampling

Soils may be sampled with a sampling tube or with a shovel. Each field, or uniform section of a field should be sampled separately. At least 20 soil cores 15 cm deep should be taken from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken the more likely the soil sample is to provide a reliable measure of the fertility in the field. One sample should not represent more than 10 hectares.

The soil can be collected in a clean pail, the lumps should be broken, the soil mixed well and a soil sample box forwarded for testing. The area sampled should be traversed in a zigzag pattern to provide a uniform distribution of sampling sites. Parts of a field that differ in appearance of soil or crop, in previous fertilization, manuring or liming should be sampled separately, even if they are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

When to Sample

Each field should be sampled once every two or three years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example with crops such as alfalfa hay, corn silage, potatoes or tomatoes) and manure is not returned. Under these conditions samples should be taken each year.

The results of soil tests are forwarded to the grower within five days of receipt of samples in the laboratory. However, to allow time for mailing and analysis, soil samples from fields to be fertilized for spring seeding crops should be taken the previous fall. Because of the rush of harvest and the frequency of poor weather late in the fall, summer may be a more convenient time to sample for some farmers. Soil samples from fields to be fertilized for fall wheat, or from hay and pasture fields to be fertilized in late summer, should be taken in the spring or early summer.

Sample Boxes and Information Sheets

Soil sample boxes and information sheets may be obtained from any local office at the Ministry of Agriculture and Food or from Agri-Food Laboratories, 503 Imperial Road, Unit One, Guelph, Ontario N1H 6T9.

Management practices which affect a soil test recommendation are: manure application, legume sod plowed down, and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation, and should be recorded on the field information sheet which must accompany the soil sample sent in for analysis.

Micronutrient Tests

Manganese and zinc tests are provided by the OMAF service. In the case of zinc on corn the soil test is best used in conjunction with visual deficiency symptoms. With manganese, plant analysis, visual symptoms and the soil test are all useful. The OMAF service does not provide a soil test for boron, copper, iron, or molybdenum.

Contamination Great care is required to prevent contamination of soil samples with micronutrients, particularly zinc. Do not use galvanized (zinc plated) soil sampling tubes to take soil samples for micronutrient tests. Do not use metal containers to collect and mix samples. Clean plastic containers in good condition should be satisfactory. Soil samples which have contacted galvanized surfaces are unsatisfactory for zinc soil tests. Be careful to keep dust around buildings etc. out of the samples.

Soil Sampling Micronutrient deficiencies frequently occur in small patches in fields. In these cases soil or plant analysis taken from the entire field are unlikely to find the problem. Sample problem areas separately.

Preventing and Correcting Manganese Deficiency Manganese is less available at high soil pH so it is important not to add more lime than is needed to correct soil acidity. For materials and rates to correct a deficiency, consult the cereals or soybeans sections under *Micronutrients*.

Table 1. Manganese Soil Test Interpretation

Manganese Soil Test	Suggested Treatments
greater than 30	Soil manganese availability is adequate for field grown crops.
16 to 30	Soil manganese availability is adequate for many crops but is approaching deficiency levels for oats, barley, wheat and soybeans. If deficiency sumptoms appear, spray with manganese. Consider a re-check for deficiency using plant analysis.
below 16	Soil manganese availability is believed to be insufficient for oats, barley, wheat and soybeans. Spray with manganese at the four-leaf stage and again three weeks later if required. Manganese deficiency has not been diagnosed on corn in Ontario even on soils which are very deficient for wheat.

Preventing and Correcting Zinc Deficiency High phosphorus in the soil and / or in the fertilizer can cause or increase the severity of zinc deficiency. Apply only the recommended amount of phosphorus. Use of animal manures can prevent or reduce zinc deficiency. Erosion control can prevent deficiency of zinc by maintaining the topsoil.

Zinc deficiency can be prevented by application of zinc fertilizer to the soil. Foliar sprays can be useful to correct a deficiency after the symptoms have appeared provided this is done early in the growing season. For materials and rates to correct a deficiency, consult the corn section under *Micronutrients*.

Table 2. Zinc Soil Test Interpretation

Zinc Soil Test	Suggested Treatments
greater than 200	You should suspect contamination of the sample or of the field.
25 to 200	Soil zinc availability is adequate for most field grown crops.
15 to 25	Zinc availability is adequate for most field crops except corn. Zinc availability is bordering on deficiency for corn. If the field sampled is uneven in soil texture, pH, or erosion, some areas may respond to zinc applications. Deficiency symptoms at the 4 to 6 leaf stage are a reliable indication of zinc deficiency (see OMAF Factsheet 100 / 531).
less than 15	Zinc is likely to be deficient for corn and should be applied in the fertilizer.

Copper soil tests are quite unreliable on Ontario soils but plant analysis is useful. Copper is unlikely to be deficient on mineral soil except perhaps on very sandy soils. Copper deficiency does occur on organic soils and is best diagnosed by plant analysis. When organic soils are first brought into cultivation, copper should be applied to the soil at 8 kg copper / ha for each of the first three years.

Boron is required on some soils for alfalfa. Boron deficiency usually occurs in dry weather so that response is erratic. Thus is has not been possible to develop a reliable soil test. Plant analysis is useful as a predicter of boron requirements as are visual symptoms on the plants. For rates of boron to correct a deficiency, consult the forages section under *Micronutrients*.

Boron deficiency has not been diagnosed on cereals, peas and beans in Ontario and boron applications to these crops, or applied to other crops in the year preceding them, can be toxic. **Boron should not be banded at seeding.**

Iron and **Molybdenum** have not been found to be deficient in field crops in Ontario.

Table 3. Analyses Available through the OMAF Soil Testing Service, at Agri-Food Laboratories, 503 Imperial Road, Unit One, Guelph, Ontario M1H 6T9

Materials	What is Analyzed	Cost Per Sample
1. Field Soils	Plant available Phosphorus, Potassium and Magnesium; pH; Lime requirements; Calcium (on tobacco soil only)	No Charge
2. Home Garden and Lawn Soils	Plant-available Phosphorus, Potassium Magnesium; pH; Lime requirement	$7
3. Commercial Turf Soil	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement	No Charge
4. Greenhouse Media Water* and Nutrient Solutions*	Plant-available Nitrogen, Phosphorus, Potassium, Calcium, Magnesium; pH; Sulphates; Chlorides; Total Salts	No Charge
5. All Soils (optional, on request only)	Plant available Manganese and Zinc	$2
6. All soils (optional, on request only)	Organic Matter	$5

**Laboratory requires 500 ml sample.*

FERTILIZER RECOMMENDATIONS

Changes in Crop or Management

Fertilizer requirements on the OMAF soil test report are for specific crop and management. If the crop management is changed in regard to legumes plowed down or manure applied, the adjustments in fertilizer requirements may be made using the manure and legume sod adjustments in Tables 4 and 5. If the crop is changed from that for which the recommendation was made, a new recommendation can be obtained by looking up the appropriate table under the specific crop section in this publication.

Nitrogen

No soil test is available which is satisfactory for nitrogen under Ontario conditions. Nitrogen fertilizer recommendations for field crops are, therefore, based on estimated crop requirements and in some cases the region of the province. Rates are adjusted downward if manure is applied, or if the previous crop contains perennial legumes such as alfalfa.

Adjustment for Legumes Plowed Down

When sod containing perennial legumes such as alfalfa, trefoil and clover are plowed under, they supply an appreciable amount of nitrogen to the following crop. The accompanying table shows reductions which should be made in nitrogen fertilizer applications to crops following sod containing legumes.

Table 4. Adjustment of Nitrogen Requirement Where Crops Containing Legumes are Plowed Down

Type of Crop	For all Crops Deduct from N Requirement kg N/ha
Less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	110
Perennial legumes seeded and plowed in the same year.	45[1]
Soybean and field bean residue	0

[1] *Applies where the legume stand is thick and over 15 cm high.*

Phosphate and Potash

Phosphate and potash recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food soil testing service at Agri-Food Laboratories, Guelph. The requirements of these nutrients are presented in this publication in tables found in the Fertilizer Section for each crop. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Where a soil test is not available, a rough estimate of requirements can be obtained from these tables using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating.

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil test rating

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizers. Only a soil test can adequately determine potash requirements.

PLANT ANALYSIS

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the "normal" and "critical" values for the crop can indicate whether nutrient supply is adequate for optimum growth.

Plant analysis is a useful supplement to soil testing for evaluation of the fertility status of crops. It is quite independent of soil testing and can provide a valuable "second opinion", especially for phosphorus, potassium, magnesium and manganese. For nitrogen and zinc it has not been very reliable. For boron and copper we don't have a reliable soil test so plant analysis and visual symptoms are the only methods for diagnosing deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed since plant analysis does not always indicate the cause of a deficiency or the amount of fertilizer required to correct it.

Table 5. Reductions in Fertilizer Application where Manure is Applied in the Same Crop Year

Class of Livestock	Nitrogen (kg/ha)			Phosphate	Potash
	F.&W.[2]	Spr.[2]	Spr.C[2]	P_2O_2(kg/ha)	K_2O(kg/ha)
Liquid Manure at 10 cubic metre / hectare (900 gal. / acre)					
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
Solid Manure at 10 tonnes / hectare (4.5 tons / acre)					
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

[1] *These adjustments are based on slightly below average quality manure.*

[2] *F.&W. denotes fall and winter applied manure; Spr. denotes spring applied and not covered immediately, including surface application after seeding; Spr. C. denotes spring applied manure injected or otherwise covered within one day of application.*

Sampling

Time of sampling has a major effect on the results since nutrient levels within a plant vary considerably with the age of the plant. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, plants suspected of being nutrient deficient should be sampled as soon as a problem appears. Samples are best taken from a problem area rather than from the entire field.

Samples for plant analysis should be taken from at least 20 plants distributed throughout the area chosen for sampling. Each sample should consist of at least 30 grams of fresh material. Problem areas should be sampled separately. When taking samples for plant analysis take care not to contaminate the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.

Sample Preparation

Samples of fresh plant material should be delivered directly to the laboratory. If they are not delivered immediately they should be dried to prevent spoilage. Samples may be dried in an oven at 65°C or less or dried in the sun provided precautions are taken to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc coated) metal, brass or copper.

Plant analyses may be obtained from several laboratories in Ontario.

MANURE

Manure can supply organic matter and an appreciable part of the nutrients required for production of crops.

Manure Storage

For maximum conservation of plant nutrients manure should be stored in a way that saves the liquid portion and allows as little exposure to the air as practicable.

Where to Use Manure

Manure is used most effectively when applied for crops that require nitrogen and on soils that require phosphorus and potassium. Manure should not be supplied at rates supplying more nitrogen than the crop requires. Corn and grass hay or pastures have higher nitrogen requirements than many other crops and therefore respond more to nitrogen in manure. Legumes such as alfalfa, trefoil and soybeans do not make efficient use of the nitrogen in the manure.

Manure on Perennial Legumes

Do not apply manure to perennial legumes such as alfalfa and trefoil when there is snow cover because ice frequently forms under the manure and can kill the plants. If manure must be applied to perennial legumes it should be applied to the thinnest or oldest stands, preferably after the first cutting.

Applications to Cereals

Manure or nitrogen fertilizers applied to cereals at rates supplying more nitrogen than the crop requires can cause lodging and should be avoided.

Manure on Grass Sod

Manure is an effective source of nutrients for grass sod. However, where manure is to be applied in late spring or summer some nitrogen fertilizer should be applied early in the spring.

Manure on Leaves

Avoid application of liquid manure to crop foliage as it can damage the crop. On perennial forages application to the foliage cannot be avoided but applications early in the spring or immediately after haying are preferred.

Short-Term Value of Manure

Table 5 shows the quantities of nutrients in manure applied in the year that the crop is grown. These values assume, for manure applied in the spring and not immediately covered with soil, that 50% of the nitrogen (75% for poultry manure), 40% of the phosphate and 90% of the potash are as available in the year of application as the nutrients in manufactured fertilizer. Thus the application of fertilizer nitrogen, phosphate and potash should be reduced accordingly.

Long-Term Value of Manure

The long-term availability of phosphorus, potassium or magnesium from manure applications in previous years is best measured by a soil test. Some of the nitrogen in cattle and swine manures also continues to become available in the years following application but in successively smaller quantities. Generally, 50 percent of the total manure nitrogen applied in the spring is available (as available as nitrogen in chemical fertilizer) in the year of application. In the second year approximately 20 percent of the remaining nitrogen becomes available, 10 percent in the third year and 5 percent in the fourth year. Thus if 20 tonnes of cattle manure per hectare were applied, the amount of nitrogen available in the first year would be 48 kg N / ha (Table 5). This is approximately one half of the total nitrogen content. The amounts of available nitrogen in years 2, 3 and 4 would be 10, 4, and 2 kg N / ha, respectively. If manure has been applied annually for a number of years, the cumulative amount of nitrogen is appreciable. For example, if 20 tonnes of cattle manure were applied each year for four years, the total available nitrogen from the manure in the fourth year would be 48 + 10 + 4 + 2 = 64 kg N / ha.

Although time and method of manure application affects the amount of available nitrogen in the first year, the amounts available in subsequent years are not affected appreciably. No adjustment should be made for the long-term effects of poultry manure because most of the available nitrogen it contains is released in the year of application.

Table 6. Soil pH at Which Lime is Recommended for Ontario Field Crops

Crops	Soil pH Below Which Lime is Recommended	Target Soil pH*
Coarse and Medium Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
Perennial legumes, oats barley, wheat, triticale, beans, peas, canola, flax	6.1	6.5
Corn, soybeans, rye, grass hay, pasture and tobacco	5.6	6.0
Fine Textured Mineral Soils (clays and clay loams)		
Alfalfa	6.1	6.5
Other perennial legumes, oats, barley, wheat, triticale, soybeans, beans, peas, canola, flax	5.6	6.0
Corn, rye, grass hay pasture and tobacco	5.1	5.5
Organic soils (peats and mucks)		
All field crops	5.1	5.5

**Where a crop is grown in rotation with other crops requiring a higher pH (for example corn in rotation with wheat or alfalfa) it is recommended that the soil be limed to the higher pH.*

Time and Method of Application

For most effective use of the nitrogen in manure it should be applied in the spring and covered with soil the same day to prevent loss of ammonia. Immediate covering with soil is estimated to provide 25% more nitrogen to the crop than where the same manure is not covered immediately. Most of the nitrogen loss to the air occurs within the first week after application. Injection of manure between corn rows after seeding, but before the corn is 30 cm high, is one way of preventing nitrogen loss and minimizing the potential for pollution of adjacent streams with phosphate from surface runoff. However phosphate applied after a crop is seeded may not be available to that crop. Phosphate fertilizer requirements should therefore not be adjusted for manure applied after seeding.

Where the manure is applied in the fall more nitrogen is lost (to the air and by leaching) than when spring applied. The nitrogen adjustments should be 50% lower for fall applied manure than for spring-applied manure which is not immediately covered (see table). Phosphate and potash are believed to be equally available from fall and spring-applied manure.

If manure must be spread in the winter, nitrogen adjustments should be the same as for fall applied. **Do not spread manure in winter or early spring on fields that are subject to runoff.**

Manure Analysis

The nutrient content of manure varies not only with the type of livestock but with their ages, the ration fed, the type of bdding or amount of water added and the method of storing the manure. Chemical analyses will indicate more accurately than this publication the amount of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. A manure analysis may be obtained from several labs in Ontario.

SEWAGE SLUDGE

Sewage sludge is a useful source of nitrogen, phosphorus and organic matter, provided it is low in heavy metals and applied under approved conditions. Consult OMAF Factsheet 100 / 541, *How and where to Use Sewage Sludge in Crop Production.*

SOIL ACIDITY AND LIMING

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most field crops grow well in a soil pH range from 6.0 to 8.0

To correct soil acidity ground limestone should be broadcast and worked into the soil at rates determined by soil test. Table 6 shows the pH values below which lime is recommended and the target soil pH to which soils should be limed, for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

Table 7. Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH.

Buffer pH	Target soil pH = 6.5 pH below 6.1	Target soil pH = 6.0 pH below 5.6	Target soil pH = 5.5 pH below 5.1
Ground limestone required - t / ha (Based on an Agricultural Index of 75)			
7.0	2	0	0
6.9	2	0	0
6.8	2	0	0
6.7	2	2	0
6.6	3	2	0
6.5	3	2	0
6.4	4	3	2
6.3	5	3	2
6.2	6	4	2
6.1	7	5	2
6.0	9	6	3
5.9	10	7	4
5.8	12	8	4
5.7	13	8	5
5.6	15	11	6
5.5	17	12	8
5.4	19	14	9
5.3	20	15	10
5.2	20	17	11
5.1	20	19	13
5.0	20	20	15
4.9	20	20	16
4.8	20	20	18
4.7	20	20	20
4.6	20	20	20

The Buffer pH

Different soils with any one soil pH value, say 5.2, will require different amounts of lime to bring the pH to a particular desired level, say 6.0, depending chiefly on the clay and organic matter content of each soil. The soil pH is used to determine which soils need to be limed but a separate soil test, the buffer pH, is run on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH) Table 7 may be used to determine the amount of lime required to reach different "target" soil pH values required for different crops.

Limestone Quality

Calcitic limestone consists largely of calcium carbonate, and dolomitic limestone is a mixture of both calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 or less as it is an excellent and inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100, calcitic or dolomitic limestone may be used.

Two main factors affect the value of limestone for soil application. One of these is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "neutralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone the higher the neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone and, hence, it neutralizes acidity much more slowly; so slowly that it is of little value. The calculation of a fineness rating for ground limestone is illustrated in Table 8.

BEFORE
USING
ANY PESTICIDE

STOP

READ THE LABEL
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Table 8. Example Calculation of the Fineness Rating of a Limestone

Particle Size	% of Sample	Effectiveness Factor	
Coarser than no. 10 sieve[1]	10	x 0 =	0
no. 10 to no. 60 sieve	40	x 0.4 =	16
Passing through no. 60 sieve	50	x 1.0 =	50
Fineness Rating		=	66

[1] *A no. 10 Tyler sieve has wires spaced 2.0 mm, and a no. 60 Tyler sieve has wires spaced 0.25 mm apart.*

The Agricultural Index

Some means of combining the Neutralizing Value and the Fineness Rating is needed to compare various limestones that are available. The index which has been developed in Ontario to do this is called the "Agricultural Index."

$$\text{The Agricultural Index} = \frac{\text{neutralizing value} \times \text{fineness rating}}{100}$$

The Agricultural Index can be used to compare the relative value of different limestones for neutralization of soil acidity[1]. Lime with a high Agricultural Index is worth proportionately more than lime with a low index because it may be applied at a lower rate. If two ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will be 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price of limestone B per tonne.

Recommendations from the OMAF soil test service are based on limestone with an Agricultural Index of 75. If you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

$$\begin{array}{c}\text{Limestone}\\\text{application}\\\text{rate from soil}\\\text{test}\end{array} \times \frac{75}{\begin{array}{c}\text{Agr. Index}\\\text{of your limestone}\end{array}} = \begin{array}{c}\text{rate of}\\\text{application}\\\text{of your limestone}\end{array}$$

For example, if you have a limestone requirement by soil test of 9 t / ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply 75 / 90 x 9 = 7.5 t / ha.

---

[1] *The Agricultural Index does not provide information about magnesium content. Dolomitic limestone should be used on soils low in magnesium.*

Tillage Depth

Lime recommendations presented here should raise the pH of the top 15 cm of a soil to the listed target pH. If the soil is ploughed to a greater depth than 15 cm proportionately more lime is required to reach the same target pH. Since lime moves very slowly in soils it should be incorporated to 15 cm depth where practical.

Lowering Soil pH

On soils with pH values below 7.0 it is possible to lower the pH (make the soil more acid) by adding sulfur or aluminum sulfate, but this is not advisable for most crops as it only hastens the time when lime will be required. If the soil pH is above 7.0 it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulfur or aluminum sulfate required.

SOIL MAGNESIUM

Magnesium is a plant nutrient which is naturally plentiful in many Ontario soils. Soils with magnesium soil tests below 20 (OMAF soil test) require magnesium application for production of most crops. Very few Ontario soils have magnesium tests below 20. If the soil pH is below 6.0, the most effective and inexpensive means of supplying magnesium is by application of dolomitic lime. If the pH is above 6.0, and the soil test 20 or below, magnesium can be supplied by either magnesium sulfate or sulfate of potash magnesia, which is a mixture of sulfate of potash and magnesium sulfate. Apply 30 kg/ha of actual soluble magnesium. These latter sources of magnesium are usually quite expensive compared to supplying magnesium from dolomitic limestone.

Potassium competes with magnesium for uptake by crops, and potash applications can therefore induce or increase magnesium deficiency. For this reason it is important to monitor soil potassium levels and to carefully control potash fertilizer applications on low magnesium soils.

Crops grown on a number of Ontario soils are low in magnesium to an extent that livestock health is affected although the crops themselves do not suffer from magnesium deficiency. In these situations it is usually much less costly to add magnesium to the animal's diet than to add it to the soil. Soil potassium should be closely monitored, however, and potash applications restricted to requirements as measured by soil test.

FERTILIZER MATERIALS

Nitrogen fertilizer materials are available in dry or liquid forms. Although there are some limitations to use of these materials (see section, *Toxicity of Fertilizer Materials*), in most cases the different sources will produce equal yields. The farmer's choice of material should therefore depend on availability, equipment for handling, and cost per kilogram of nitrogen, plus the cost of application.

A farmer should first calculate the cost per kilogram of nitrogen for various sources delivered to his farm. Depending on the rate of application, the cost per hectare can be determined. Add to this the cost of application per hectare before deciding which nitrogen source to use.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen (N), not kilograms of materials, are used. The following tables show the percentage of fertilizer nutrient contained in different materials.

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Table 9. Fertilizer Materials - Primary Nutrients

Nitrogen Materials	Form	% Nitrogen (N)
Ammonium nitrate	Dry	33 to 34
Urea	Dry	45 to 46
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid[1]	20
Ammonium nitrate-urea	Liquid	28
Ammonium nitrate-urea	Liquid	32
Ammonia ammonium nitrate-urea	Liquid[1]	41
Ammonia-ammonium nitrate	Liquid[1]	41
Anhydrous ammonia	Liquid[1]	82
Phosphate Materials		**% Phosphate (P_2O_5)**
Single superphosphate		20
Triple superphosphate		44 to 46
Monoammonium phosphate		48 to 52
Diammonium phosphate (18-46-0)		46
Potash Materials		**% Potash (K_20)**
Muriate of potash		60 to 62
Sulfate of potash		50
Sulfate of potash magnesia (11% Mg)		22
Potassium nitrate (13-0-44)		44

[1] *Liquid under pressure.*

Table 10. Soil Conductivity Reading Interpretation

Conductivity "salt" reading millisiemens/cm	Rating	Plant Response
0-0.25	L	Suitable for most plants if recommended amounts of fertilizer are used.
0.26-0.45	M	Suitable for most plants if recommended amounts of fertilizer are used.
0.46-0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants.
0.71-1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

For greenhouse soils the OMAF soil test uses a larger soil sample and measures conductivity on a saturation extract. For greenhouse crops using that method conductivity readings up to 3.5 millisiemens/cm are acceptable.

TOXICITY OF FERTILIZER MATERIALS

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the seed. Fertilizers vary in toxicity per unit of plant nutrient due to: (1) differences in the amount of salts contained in the fertilizer per unit of plant nutrient, (2) differences in solubility of the salts in the soil, and (3) a few specific materials or elements are particularly toxic (for example, anhydrous ammonia and boron). Phosphate fertilizers are usually low in toxicity because a large portion of the phosphate is precipitated in the soil before it can reach the plant roots. The concentration of phosphorus in soil solution at any one time is very low.

Fertilizer Materials - Secondary and Micronutrients

If secondary or micronutrients are proven to be needed (by soil and/or tissue tests) then the most common sources of these are:

Magnesium (Mg)

Dolomitic Limestone	6-13% Mg
Epsom Salts (Magnesium sulphate)	10.5% Mg
Sulphate of Potash Magnesia	11% Mg

Boron (B)

Various boron sources are available	8-21%B

Copper (Cu)

Copper Sulphate	13-25% Cu
Copper Chelates	5-13% Cu

Manganese (Mn)

Manganese Sulphate	26-28% Mn
Manganese Oxysulphate	28% Mn
Manganese Chelates	5-12% Mn

Molybdenum (Mo)

Sodium Molybdate	39% Mo

Zinc (Zn)

Zinc Sulphate	36% Zn
Zinc Chelates	7-14% Zn
Zinc Oxysulphate	18-36% Zn

Various fertilizer companies have available, in addition to the above micronutrient sources, premixes containing one or more of the above micronutrients.

Individual Factsheets are available on some of these micronutrients. For a list of these see Publications section.

SOLUBLE SALTS IN FARM SOILS

High concentrations of water soluble salts in soils can prevent or delay germination of seeds and can kill established plants or seriously retard their growth.

Ontario soils are naturally low in soluble salts. Soluble salts therefore rarely cause a problem in crop production and are not routinely measured in soil tests.

Soluble salts in soils can result from excessive applications of fertilizers and manures, runoff of salts applied to roads, and chemical spills on farm land. High concentrations of soluble salts in or near a fertilizer band can cause serious temporary problems, affecting seed germination and/or early plant growth without seriously affecting the salt concentrations in the remainder of the soil. A given amount of salt in a soil provides a higher salt concentration in soil water if the amount of water is small. Soluble salts also interfere with the uptake of water by plants. For these reasons plant growth is most affected by soluble salts in periods of low moisture supply (during drought periods).

Soluble salts can be measured readily in the laboratory by measuring the electrical conductivity of a soil water slurry. The higher the concentration of water soluble salts the higher the conductivity. The following table provides an interpretation of soil conductivity readings as read in Ontario field soils in a 2:1 water: soil paste, the procedure used by the OMAF soil testing service.

Nitrogen Fertilizers

Ammonium nitrate, monoammonium phosphate and ammonium sulphate are similar in toxicity and much safer than anhydrous ammonia, aqua ammonia or urea. Diammonium phosphate is more toxic than monoammonium phosphate but less toxic than urea. More care should be taken, particularly with sensitive seeds and on coarse-textured soil (sand and sandy loam), than is required with ammonium nitrate, or monoammonium phosphate.

Because anhydrous ammonia and aqua ammonia are extremely toxic fertilizers, they should not be placed near seeds. It is preferable to make pre-plant applications crossways to the direction in which the crop will be planted.

Urea is toxic when banded with or near the seed but is safe when broadcast at rates normally used. Fertilizers containing more than half as much nitrogen as phosphate frequently contain urea.

Phosphate Fertilizers

Most common phosphate fertilizers are not very toxic to seeds and plants and no limit is normally set for the safe rate which may be applied with, or near, the seed of field crops.

Diammonium phosphate is more toxic than other phosphate fertilizer - see above under nitrogen fertilizers.

Potash Fertilizers

Muriate of potash (KCl) is the most common source of potassium in fertilizers, and is less toxic per unit of plant nutrients than most nitrogen fertilizers.

Sulphate of potash (K_2SO_4) is less toxic than muriate of potash.

Sulphate of potash-magnesia has approximately the same toxicity per unit of potassium as muriate of potash.

Potassium nitrate is one of the safer sources of potassium.

Fertilizers Containing Micronutrients

Fertilizers containing micronutrients (boron, copper, iron, manganese or zinc) are more toxic than the same grades without micronutrients and maximum safe rates should be reduced. Boron is particularly toxic, and should be applied with caution particularly when banded.

Guidelines for Safe Rates of Nutrients Applied at Seeding

Fertilizer toxicity varies widely, depending on the amount of soil moisture. To insure completely safe rates of banded fertilizer for all seeding conditions would require extremely low rates of application. The maximum safe rates suggested here will probably reduce or delay germination, or retard growth in up to 10% of the cases where they are used. In most cases, it is advisable to use lower rates of fertilizer at seeding than those listed in the following table. If fertilizer requirements are high, it may be better to broadcast most of the fertilizer required and to band only a small portion at seeding. Fertilizers containing the micronutrients boron, copper, iron, manganese and zinc are more toxic, and the safe rates recommended will be lower than those shown in this table.

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Table 11. Maximum Safe Rates of Nutrients

SPRING OATS AND BARLEY (fertilizer with the seed)	
Sands and Sandy Loam Soils	35 kg nitrogen or 55 kg (nitrogen + potash) per hectare. If **diammonium phosphate** (18-46-0) is the N source, 20 kg nitrogen or 35 kg (nitrogen + potash) per hectare. If urea is the N source, 10 kg nitrogen or 30 kg (nitrogen + potash) per hectare[1].
Loams, Silt or Clay Loams	45 kg nitrogen or 70 kg (nitrogen + potash) per hectare. If **diammonium phosphate** (18-46-0) is the N source, 30 kg nitrogen or 55 kg (nitrogen + potash) per hectare. If urea is the N source, 10 kg nitrogen or 30 kg (nitrogen + potash) per hectare[1].
WINTER WHEAT, TRITICALE OR BARLEY (fertilizer with the seed)	
All Soils	15 kg nitrogen or 30 kg (nitrogen + potash) per hectare. **Diammonium phosphate** (18-46-0) or **urea** should not be drilled with the seed of fall-seeded cereals[1].
CORN (fertilizer with the seed)	
All Soils	7 kg (nitrogen + potash) per hectare in one metre rows. **Diammonium phosphate** or **urea** should not be applied with the seed of corn. At row widths other than one metre, the rate may be adjusted to provide the same maximum concentration in the row (in 50 cm rows the safe rate = 100/50 x 7 = 14 kg (nitrogen + potash) per hectare).
CORN (fertilizer banded 5 cm to the side and 5 cm below the seed)	
All Soils	55 kg nitrogen or 90 kg (nitrogen + potash) per hectare. If **urea** is the N source, 30 kg nitrogen or 60 kg (nitrogen + potash) per hectare. At row widths other than one metre, the rate may be adjusted to provide the same maximum concentration in the row (in 50 cm rows the safe rate = 100 / 50 x 55 = 110 kg N per hectare).
CANOLA (fertilizer with the seed)	
	up to 20 kg/ha phosphate fertilizer may be drilled with the seed as superphosphate or monoammonium phosphate. Nitrogen (except in the form of monoammonium phosphate) and potash should not be applied with the seed.
CANOLA (fertilizer banded no less than 2 cm to the side and 2 cm below the seed)	
	30 kg/ha of nitrogen or 50 kg/ha (nitrogen + potash) along with all the phosphorus required. Urea should not be banded.
FLAX (no fertilizer with seed)	
All soils	Rates recommended are normally safe when broadcast.
PEAS, BEANS AND SOYBEANS (no fertilizer with seed)	
All soils	(fertilizer banded 5 cm to the side and 5 cm below the seed) 30 kg nitrogen or 90 kg (nitrogen + potash) per hectare. Rates recommended are normally safe when broadcast.

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[1] *Fertilizers containing more than half as much nitrogen as phosphate (e.g. 16-16-16) frequently contain urea. Note that fertilizers containing urea are not suitable for banding at seeding in many cases.*

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CORN

CROP MANAGEMENT

Seeding Date and Planting Depth

The best yields are usually obtained from corn planted in the first half of May because the crop is able to use the full growing season. Early planting also results in earlier maturity in the fall, reducing the risk of damage from an early fall frost or adverse weather at harvest. The optimum planting date is around May 7 in southwestern Ontario and May 10 in central and eastern Ontario. Delaying planting past the optimum date can result in yield reductions averaging 40 kg/ha per day of delay.

It is advisable to start planting slightly before the optimum date. Take advantage of good planting conditions when they occur. The risk of a yield reduction from planting a bit too early is less than that from planting too late.

Corn will germinate if the soil temperature is over 10C, but emergence will be very slow at soil temperatures under 15C. When planting early or in cold soil, place the seeds 2 to 3 cm deep, because the soil will be warmest near the soil surface. Deeper planting will result in delayed emergence and uneven stands.

When planting in warm soil, the seeding depth generally should be such that the seed is placed in moist soil. Excessively deep planting should be avoided. Seeds planted more than 7 cm deep may have difficulty emerging, especially on fine-textured or compacted soils where crusting may be a problem.

Plant Populations

The plant populations discussed here are suggested final plant stands. Because not all seeds emerge, it is necessary to seed at slightly higher rates. When planting early in the season or when the soil is cold, a seeding rate 10% higher than the desired final stand is recommended (see Table 12). When soils are warmer, an adjustment of 5% is sufficient.

In Ontario, corn has commonly been grown at populations of 52,000 to 58,000 plants per hectare. These populations can produce good yields over a wide range of growing conditions without excessive lodging. In recent years, hybrids have been developed which tolerate higher plant densities without excessive lodging or barrenness. Under good growing conditions, higher yields can be obtained by using plant populations as high as 67,000 plants per hectare.

Increased plant densities are not appropriate for all situations because of the many factors that interact with plant population to place the crop under stress. Factors such as drought, weeds, insects, diseases, soil compaction, inadequate fertility and poor drainage all serve to exaggerate the stressful effects of increased plant populations. The more severe these other stresses are, the lower the optimum plant population will be.

Yield increases from increased plant densities have been least in the warmer parts of Ontario (over 2900 heat units for grain corn or 3100 heat units for whole-plant silage). Many factors, including larger plant size and higher temperatures at silking, are responsible for this difference. In these warmer areas, optimum plant populations will be lower than those discussed below.

Hybrid selection is a critical factor in determining the optimum plant population. Many hybrids yield well at 55,000 plants per hectare, but cannot tolerate higher densities, especially if growing conditions are less than ideal. Only a few hybrids can tolerate a population of 67,000 plants per hectare. The population selected must be suitable for the hybrid being grown and the growing conditions likely to be encountered. It may be necessary to change the plant population when changing hybrids or fields.

Experience with previous corn crops can provide guidelines for choosing a plant population. Where yields have been low and lodging a problem, even though good-standing hybrids have been grown, final stands as low as 50,000 plants per hectare are recommended. These lower populations should be considered on soils low in fertility, susceptible to drought, imperfectly drained, or otherwise in poor condition.

An increase in plant density is most likely to result in improved grain yield in fields that already have a history of high yields with little lodging. These will be fertile, well-drained fields with good moisture-holding capacity. In such cases, consideration should be given to increasing plant population. There appears to be little advantage to plant densities over 67,000 plants per hectare for grain corn.

A benefit from higher plant densities will most likely be obtained when corn is planted early. Later plantings result in large, leafier plants and more inter-plant competition. Late-planted corn will also be silking later when the risk of drought or heat-stress is greater. Therefore, plant density should be reduced as planting is delayed.

Because lodging is of less concern in corn grown for whole-plant silage, higher plant populations can be used than for grain corn. In areas with less than 3100 heat units, final stands of 60,000 to 70,000 plants per hectare will produce higher silage yields with little effect on the grain content or moisture level of the silage. These populations should be used only where it is certain that the field will be harvested for whole-plant silage. Fields left for grain at these densities could lodge excessively. Even for silage, the population should not exceed 60,000 plants per hectare on soils that are droughty or otherwise in poor condition.

Table 12. Centimetres Between Seeds to Achieve Specific Populations

Final[1] Plants/ hectare	Seeds[2] Per hectare	Row Width[3] - centimetres						
		71	76	81	86	91	97	102
40,000	43,900	32	30	28	26	25	23	22
45,000	50,000	28	26	25	23	22	21	20
50,000	55,600	25	24	22	21	20	19	18
55,000	61,100	23	22	20	19	18	17	16
60,000	66,700	21	20	19	17	16	15	15
65,000	72,200	20	18	17	16	15	14	14
70,000	77,800	18	17	16	15	14	13	13

[1] *hectare* = 2.47 acres

[2] *Based on 10% loss of plants. With planting after the optimum date, a loss of 5% of the plants may be more realistic.*

[3] *1 centimetre* = 0.39 inches.

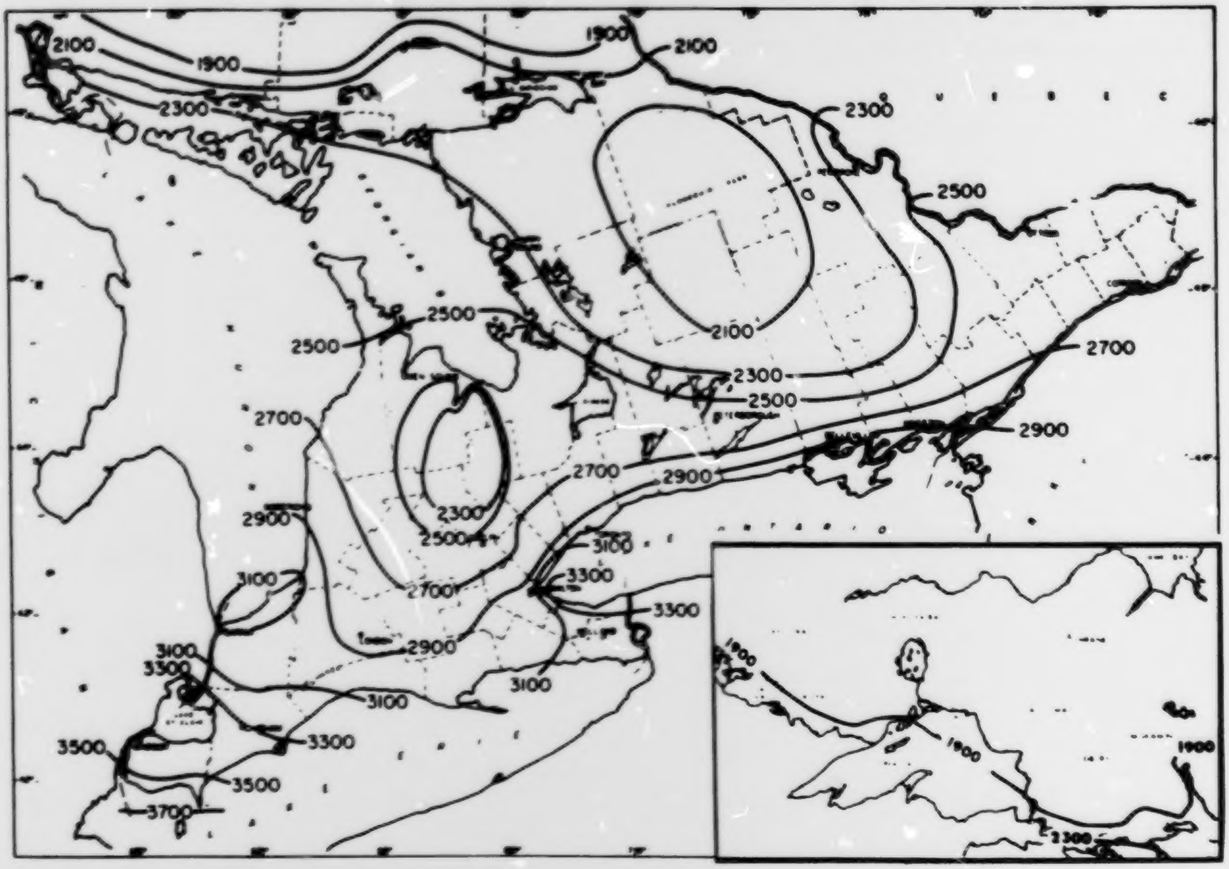

Figure 1. Heats Units Available for Corn Production

HYBRID SELECTION

Grain Corn

Corn hybrids suitable for Ontario are evaluated for yield, maturity and standability in tests conducted across the province each year. The results are published annually in the *Ontario Hybrid Corn Performance Trials* report. This report is a valuable guide in selecting hybrids. The first consideration in choosing a hybrid must be the ability to reach the proper stage of maturity in the fall. Once the maturity range is established, the final selection should be based on both yield and standability.

Silage Corn

Experience has demonstrated that hybrids producing grain yields also produce good silage yields. When choosing hybrids specifically for whole-plant silage, a yield advantage can usually be obtained by selecting hybrids rated 100 to 200 heat units later than those selected for grain.

Choosing Hybrids for Your Farm

Locate the vicinity of your farm on the map in Figure 1 and estimate the number of heat units available. Since the number of heat units received will also be influenced by the slope, elevation and soil type, the average heat units received by a farm may vary over the long term from the estimate by up to 50 heat units. Once you have established the heat unit rating for your farm, select hybrids requiring that number of heat units or fewer. This should ensure that corn planted by mid-May will reach full maturity before a killing frost nine years out of ten.

If planting is delayed beyond mid-May, reduce your estimate of the number of heat units available by 100 for each week that planting is delayed. For example, in a 2900 heat unit area, if planting is delayed to May 24, select a hybrid that requires no more than 2800 heat units to mature.

FERTILIZERS FOR CORN

Nitrogen

Nitrogen (N) Requirements for Corn in Southwestern Ontario

The most profitable rate of nitrogen application is affected by the market price of corn relative to the cost price for nitrogen as expressed by the price ratio of corn to nitrogen.

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Table 13. Prices of of Common Nitrogen Fertilizers Corresponding To Fixed Prices for Nitrogen (N)

Nitrogen[1] N$/kg	Anhydrous Ammonia (82% N)	Urea (46% N)	28% Solution (28% N)
	Dollars per Tonne		
0.40	328	184	112
0.50	410	230	140
0.60	492	276	168
0.70	574	322	196
0.80	656	368	224
0.90	738	414	252

[1] $$\text{Cost of Nitrogen (N) \$/kg} = \frac{\text{Cost of Nitrogen Fertilizer in \$/Tonne}}{\text{\% Nitrogen (N) in the Fertilizer x 10}}$$

Table 14. Relation of Corn and Nitrogen Prices to the Most Profitable Sidedressed Nitrogen Applications for Southwestern Ontario[1,2]

Price Ratio	Expected Yield[3] — t/ha grain (silage) 6 (30)	7 (35)	8 (40)	9 (45)	10 (50)
	Most profitable nitrogen application[4] kg N/ha				
100	75	80	90	95	105
200	115	125	140	150	160
300	135	150	165	185	200
400	145	160	180	200	220

100 kg/ha = 90 lb/ac.

[1] *The Counties of Essex, Kent and Lambton and clay and clay loam soils in Elgin, Huron, Middlesex and Perth*

[2] *To use the table, the price of corn must be known or estimated. Corn at $105/t and nitrogen at $0.70/kg results in a price ratio of 150 (105 ÷ .70). At these prices and an expected yield of 7 t/ha you should use approximately 100 kg N/ha.*

[3] *Expected yield is that yield which from experience you expect from your soil, climate and management.*

[4] *Nitrogen rates presented are for sidedress application. For preplant application an additional 30 kg N/ha should be applied. Nitrogen rates should be adjusted downward if the preceding crop was a legume sod (See Nitrogen Adjustment for Legumes Plowed Down section), or if manure is applied (See Manure Section in Soils).*

Nitrogen (N) Requirements for Corn in Central and Eastern Ontario

Table 15. Nitrogen (N) Requirements for Corn in Eastern and Central Ontario and sandy loam, loam and silt loam soils in Elgin, Huron, Middlesex and Perth Counties

Expected Yield[1,3] Shelled Corn	Silage Corn	Nitrogen[2,3](N) Required
t/ha	t/ha	kg/ha
5	25	80
6	30	100
7	35	120
8	40	140
9	45	160

[1] *Expected yield is that yield which your experience indicates you should obtain under your conditions of soil, climate and management.*

[2] *Nitrogen rates should be adjusted downward if the preceding crop was a legume sod (see Nitrogen Adjustment for Legumes Plowed Down section) or if manure is applied (see Manure Section in Soils).*

[3] *1 t/ha = 0.45 ton/ac = 16 bu/acre. 100 kg/ha = 90 lb/ac*

Phosphate and Potash

Phosphate and potash requirements for corn are presented in Table 16.

For information on use of this table see *Soil Testing Section in Soils*

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Table 16. Phosphate and Potash Requirements for Corn Based on OMAF Soil Tests

Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] required — kg/ha	Ammonium Acetate Potassium Soil Test (ppm)	Rating	Potash (K_2O)[1] required — kg/ha
0 - 3		110	0 - 15		170
4 - 5	LOW	100	16 - 30	LOW	160
6 - 7		90	31 - 45		140
8 - 9		70	46 - 60		110
10 - 12		50	61 - 80		80
13 - 15	MEDIUM	20	81 - 100	MEDIUM	50
16 - 20		20	101 - 120		30
21 - 30	HIGH	20	121 - 150	HIGH	0
31 - 60	VERY HIGH	0	151 - 250	VERY HIGH	0
61 +	EXCESSIVE[2]	0	251 +	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied reduce the fertilizer application according to the amount of quality of manure (see Manure section in Soils) Example of fertilizer application: If the expected yield of corn grain in a particular field in Oxford County is 7 t/ha, the nitrogen recommendation would be 120 kg/ha (see Table 15). If the soil tests are 11 for phosphorus and 110 for potassium, the phosphate requirement is 50 kg/ha and the potash requirement 30 kg/ha (from above table). The phosphate can be supplied by 160 kg/ha (50 ÷ 32 x 100) of 8-32-16 applied 5 cm to the side and 5 cm below the seed at planting. It would supply 12 kg nitrogen and 25 kg potash/ha. The remaining 108 kg N/ha can be supplied with 130 kg (108 ÷ 82 x 100) kg of 82-0-0.*

[2] *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may induce zinc deficiency on soils low in zinc and increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Plant Analysis

Sample the mid-third of the ear leaf at silking. However, plants suspected of nutrient deficiency should be sampled as soon as the problem appears. For plants with six leaves or less sample the total above ground plant. From seven leaves to silking sample the youngest fully developed leaf. Expert help will be required to interpret plant analysis results when the samples are not taken at silking.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis Section* in *Soils*.

Table 17. Interpretation of Plant Analysis for Corn[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	2.5	3.5
Phosphorus (P)	%	0.15	0.50
Potassium (K)	%	1.2	2.5
Calcium (Ca)	%	—	1.5
Magnesium (Mg)	%	0.10	0.60
Sulphur (S)	%	0.14	—
Boron (B)	ppm (ug/g)	2	25
Copper (Cu)	ppm	2	20
Manganese (Mn)	ppm	15	150
Zinc (Zn)	ppm	14	70

[1] *Values apply to the mid-third of the ear leaf sampled at silking.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Micronutrients and Magnesium

Although magnesium is plentiful in most soils in Ontario, magnesium deficiency does occur on acid, sandy soils. The symptoms appear first as yellow striping of the lower leaves. As the deficiency worsens, the upper leaves may become striped while the lower leaves turn reddish-purple.

All soil samples analysed under the OMAF soil testing program are tested for magnesium. This test is a reliable guide for determining magnesium requirements.

Dolomitic lime is an excellent source of magnesium. Where limestone is required to correct soil acidity, dolomitic lime should be used whenever the magnesium test is less than 100. For further information, see OMAF Factsheet, *Soil Acidity and Liming*, Agdex 534.

Few soils that do not need lime will require magnesium. Magnesium application is recommended only if the magnesium test is under 20. On these soils magnesium can be supplied either by magnesium sulphate or, if potassium is also required, by sulfate of potash magnesia. Apply 30 kg/ha of water soluble magnesium.

Over-application of potassium can induce magnesium deficiency. For this reason it is important to monitor soil potassium levels closely, and restrict potash application rates to those recommended by the OMAF soil test.

Zinc deficiency occurs on corn in Ontario. Visual symptoms on the leaves are the best means of determining deficiency but soil tests are also useful. Response to zinc should not be expected unless deficiency symptoms are quite marked.

When zinc is required it may be applied to the soil mixed in the fertilizer at rates supplying 4 to 14 kg zinc/ha. The higher rate should be sufficient for up to 3 years. Not more than 4 kg zinc/ha should be banded at planting. Zinc may be applied as a foliar spray at rates supplying 60 g zinc / 100 litres (0.6 lb / 100 gal). A wetting agent should be added. Spray to leaf wetness. For further information, *see Micronutrients in Soil Management* section and OMAF Factsheet, *Zinc Requirements for Field Crops*, Agdex 100 / 531.

Other micronutrients are not likely to be deficient on corn in Ontario.

Methods of Application

Nitrogen should be applied in the spring with the major portion either as a preplant application or side-dressed before the corn is 30 cm high. Fall application of nitrogen is not recommended. In Essex, Kent and Lambton Counties and on the clay and clay loam soils of Huron, Perth, Middlesex, and Elgin, preplant applications of nitrogen have not been as efficient as side-dressed applications. For preplant application an additional 30 kg N / ha should be applied. On these soils in this area anhydrous ammonia has produced 3-5% higher yields than ammonium nitrate or urea. In the remainder of Ontario, preplant application is equal to side-dress application, and there is no yield advantage for anhydrous ammonia over ammonium nitrate or urea.

Solid forms of nitrogen or 28 to 32% solutions may be applied to the surface of the soil without incorporation (However, urea applied on crop residues should be incorporated into the soil immediately). Under dry conditions the effectiveness of all forms of nitrogen may be improved by incorporation. If nitrogen fertilizer solutions contact leaves, burning and yield reductions are likely to occur.

Anhydrous ammonia, applied with conventional equipment, should be placed a minimum of 15 cm deep in the soil. For preplant applications, ammonia outlets should be no more than 50 cm apart. For wider spacings, a 4 day waiting period before planting is recommended to avoid damage to the seedlings.

When appropriate equipment is used, ammonia may be applied with a cultivator or disc a minimum of 10 cm deep with the ammonia outlets spaced no more than 50 cm apart.

The major portion of the phosphorus and potassium may be broadcast and plowed or worked into the soil either in the fall or spring. However, where soil tests show a requirement for these nutrients a fertilizer containing nitrogen and phosphorus or nitrogen, phosphorus and potassium should be applied as a starter at planting time. For further information see Table 11, *Maximum Safe Rates of Nutrients* in the *Soils* section.

DISEASE AND INSECT CONTROL IN CORN

(see also Pesticides section)

Seed Treatment

Follow the precautions under *Seed Treatments* in *General Information on Pesticide Usage* section, when applying chemical seed treatments.

Seed corn sold in Ontario has been treated with a fungicide, such as captan, Vitaflo 280 or thiram, for protection against **seed decay** organisms. A treatment may also have been applied to control insects that attack seed in storage. Additional treatments to protect seeds from soil-inhabiting insects should be applied every year. Use diazinon to reduce damage by **seed maggots** and lindane for protection from **wireworms**. Seed treatment combinations of diazinon and lindane are available from seed suppliers and should be applied as recommended. Follow the directions on the label with care. Thorough mixing is important.

Apply insecticides to the seed just before planting or mix them with seed in the planter box. Use a wooden paddle to mix the chemicals and seed.

DISEASES

General Preventive Measures

1. Plant hybrids resistant to leaf blights and stalk rot (see below and check with seed company).
2. Rotate corn with other crops to help prevent disease buildup. Rotation is particularly important when reduced tillage is practised.
3. Chopping of corn stalks and leaves, and plowing under of the residues, help to kill overwintering disease fungi.
4. Minimize plant stress by:
   a. Avoiding plant populations that are too high for the hybrid grown.
   b. Maintaining high soil fertility, good soil structure, and good drainage.

Leaf blights Northern leaf blight and leaf spot sometimes appear especially on lower leaves. Both diseases are favored by moderate temperatures, long dew periods, and rain. Most recommended hybrids have good resistance. See OMAF Factsheet, *Leaf Diseases of Field Corn*, Agdex 111 / 632.

Eyespot is usually severe only in wet seasons in fields with much corn debris from the previous season or on highly susceptible hybrids. Crop rotation and clean plowing of corn debris help to reduce disease severity.

Anthracnose is now widely distributed in southern Ontario and may become severe in wet years. The disease may affect both leaves and stalks. Rotation of corn with other crops and plowing down corn residues cleanly will reduce disease severity. See OMAF Factsheet, *Leaf Diseases of Field Corn*, Agdex 111 / 632.

Bacterial leaf blight (Stewart's Wilt) occurs in southwestern Ontario, mainly in Essex and Kent counties. Elongate water-soaked streaks with wavy margins appear on the leaves, especially after silking. When disease develops earlier the plants may wilt. The disease can be transmitted in seed or by the corn flea beetle, and may spread from sweet corn which is more susceptible than field corn.

Stalk Rot Grow hybrids with low stalk breakage counts, as listed in the current Ontario Hybrid Corn Performance Trials. Copies are available from your county office of the Ministry of Agriculture and Food. Stalk rot is often serious in fields with high plant populations, low fertility, and poor soil conditions. Harvest as early as possible because stalk rot develops mostly on mature plants and becomes a greater problem the longer the crop is left in the field.

Ear Rot Pink, white, green and black molds may develop on ears. The pink molds, and less often the white molds, may produce toxins, including estrogens and vomitoxin, which have serious effects on livestock, especially pigs and poultry. The green and black molds do not normally pose a problem except when, in great abundance, they may put livestock off feed. Development of the ear rot is stopped when corn is dried, or ensiled, but the level of harmful toxins, if present, remains unchanged. Where corn is stored in cribs these fungi will, under favorable weather conditions, continue to grow and produce toxin until corn moisture drops below 20%. See OMAF Factsheet, *Moldy Feeds and Swine Diseases*, Agdex 440 / 60.

Storage and Feeding Precautions

1. Exercise caution in feeding moldy corn, especially to hogs. Pink or reddish molds are particularly harmful.
2. For assistance with problems of moldy feeds, contact the county office of the Ontario Ministry of Agriculture and Food. It may be recommended that the feedstuff be analyzed for toxins.
3. Avoid cribbing corn with pink ear rot.

Head Smut This disease was first observed in Ontario in 1979. Incidence of head smut in field corn has been low since 1980. However, spores of the head smut fungus survive in the soil for several years. This disease is easily confused with common smut but is much more destructive. Recommended hybrids differ in degree of resistance to head smut. Consult OMAF Factsheet, *Head Smut of Corn*, Agdex 111 / 632 for further details of the disease.

INSECTS

Corn Rootworms There are two species of corn rootworms that damage corn in Ontario. The northern corn rootworm is still the predominant species east of Oshawa, while the western corn rootworm is the predominant species west of Oshawa.

The larval stage of these species feed on corn, causing damage by tunneling through and pruning roots from mid June to mid July. When fully grown the slender, white larvae are about 1.5 cm long. The northern adult is a plain yellow or green beetle about 0.5 cm in length; the western adult is yellow with black markings and is slightly larger than the northern adult. Both adults feed on corn silks from August to the first frost. See OMAF Factsheet, *Corn Rootworms*, Agdex 111 / 622.

Crop rotation is recommended to control both species of rootworms. If crop rotation is not practical and the western corn rootworm is predominant in your area, it may be necessary to treat 2nd-year corn, especially on clay soils. If extensive goosenecking occurs, consider treatment with insecticide the following spring. Use a planter-mounted granular insecticide applicator with a spreader attachment to place an insecticide in at least a 15-cm band in front of the press wheel but not in contact with the seed because of possible phytotoxicity. Calibrate the applicator each year and when switching chemicals or changing planting speed. Do not use a broadcast application. To avoid wind drift and poor control, mount the spreaders as close to the ground as possible, and use wind guards. Any one of the following insecticides may be used. Consult the insecticide label for manufacturer's directions for use.

Poor control has often been the result of:

1. Poor calibration.
2. Applying less than recommended rates.
3. Poorly maintained equipment.
4. Absence of wind guards for proper placement of insecticide on windy days.

Under light to moderate rootworm pressures all of the insecticides listed below have significantly reduced the damage caused by corn rootworms. Under heavy insect pressures the **approximate** order of effectiveness is as listed below.

Table 18. Corn Rootworm Control

	Rate of Product		
Insecticide[1] Applied in a 15-cm band	Grams per 100m of row Any Row Width	kg / ha at Row Width of 90 cm	75 cm
Counter 15 G[2]	75	8.3	10.0
Dyfonate 20 G[3]	55	6.1	7.3
Lorsban 15 G[4]	75	8.3	10.0
Thimet 15 G	75	8.3	10.0
Furadan 10 G	110	12.2	14.6
Di-System 15 G	75	8.3	10.0
720 LC[5]	15 mL	1.6 L / ha	2.0 L / ha
Dasanit 15 G	75	8.3	10.0

G (Granular); LC (Liquid Concentrate).

[1] There is concern that the continued use of one material may result in development of corn rootworms resistant to, or soil microorganisms capable of rapid degradation of, that insecticide. All of these insecticides are extremely poisonous to the operator. Handle with care. Follow all safety precautions on the label. Only purchase what is needed for one year. Store under lock and key and not with food or animal feed. For additional information see Pesticides section.

[2] Also controls seed corn maggot and wireworms.

[3] Also controls seed corn maggot.

[4] Placement behind the planter shoe and ahead of the press wheel improves performance.

[5] Liquid concentrate must be sprayed in a 15-cm band for control. Do not apply with liquid starter fertilizer because the band is not wide enough for control of rootworms.

European Corn Borer The stalk breakage problem in any year cannot be predicted but will depend on many factors including weather conditions, stalk rot, wind and borers.

The cream-colored female moth usually lays her eggs on the underside of corn leaves, beginning in early June in southwestern Ontario and somewhat later in other parts of the province. After hatching, the young borers feed on the leaves, giving them a pinpricked appearance. Sometimes the feeding scars are elongate. Later, the borers work downward into the "throat" (whorl) of the plant and feed on the developing leaves. Afterwards, they enter the stalk. Control is effective only if the borers are destroyed before they enter the stalk. It is most important to select a hybrid with good standability and thus some resistance to breakage. Avoid plant populations that are too high for the hybrid grown. Higher plant populations lower stalk quality and can result in more breakage. In addition, growers should plant as early as feasible to reduce the infestations by the second generation where it occurs, and to obtain as early a harvest as possible. Harvest as soon as suitable moisture levels are reached to decrease losses from dropped ears and broken stalks which occur during autumn storms.

European Corn Borer Strains There are two distinct strains of the European corn borer in Ontario. Most areas have the strain with a single generation per year, but south of a line from Sarnia to London and Simcoe, the strain has two generations per year. There is some resistance to leaf feeding by the single-generation strain and the first generation of the two-generation strain, but none by the second generation feeding where it occurs. The resistance ratings, as such, are not available but are reflected, among other factors, in the standability ratings available in the current Ontario Hybrid Corn Performance Trial Report.

Two-Generation Area In the southwestern area where the two-generation strain occurs, the second generation is larger than the first, is more abundant in late-planted corn, and is responsible for most of the ear loss due to damaged shanks and stalks. For this reason the non-chemical recommendation listed above are generally preferable. If insecticides are applied, use a material listed below but apply it in August against the second generation. Eggs for this generation are laid over a three-week period. Probably more than one application would be required for significant control.

One-Generation Area Where only one generation occurs, losses can be high enough to warrant control. You should examine the plants for borer feeding before tassels show in the whorl or when plants are about 60 cm tall. Examine the plants at 10-day intervals and spray if you find that more than 50% of the plants have feeding scars. Two applications, 7 to 10 days apart, may be needed for significant control. Once the larvae bore into the stalks, treatments are not effective and should not be applied. In some years the one generation strain produces a partial second generation. This flight is usually small and occurs towards the end of August. It does not pose a serious threat to corn. Fur further information, see OMAF Fachsheet, *European Corn Borer*, Agdex 111 / 622.

Table 19. European Corn Borer Control

Insecticide	Product per ha
Cymbush 250 EC	280 mL
Ripcord 400 EC	175 mL
*Furadan 480 F	1.1 L
Sevin XLR[1] 480 Su	2.5-4.0 L

EC (Emulsifiable Concentrate); F (Flowable); Su (Suspension)

[1] Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees foraging for corn pollen. Follow precautions applying to honeybees. See Protect Honeybees section.

**Minimum period before re-entry is 48 hours. See Reentry into Treated Areas.*

Bees often visit sweet and field corn to collect pollen. Where spraying is being done bee poisoning may result. **Sevin and Furadan are highly toxic to bees** but Sevin is the most damaging since it is carried to the hive and poisons the brood. If bees are in the area, advise local keepers of spraying activity and do not use Sevin. Your local agricultural representative has a listing of beekeepers in your area. Damage to bees is reduced when sprays are applied in early morning or late evening when bees are not foraging. Do not treat when the wind is blowing. Avoid contamination of roadsides and adjacent fields where plants may be in bloom.

Cutworms They are found in the soil and attack seedling corn in the two-to-five-leaf stage. Plants suddenly wilt because the stem is hollowed out or cut off at or just below ground level. The cutworms can usually be found in the soil within a few centimetres of damaged plants. There are a number of species of cutworms and they may be gray to dark brown in color and striped or mottled. Mature cutworms are about 3.5 cm long. Cutworms that are nearly mature (over 2.5 cm long) are difficult to control but they will stop feeding in a few days when they reach full size. Insecticide application is not recommended in this case because most of the damage is done and it is better to wait a few days and replant. Treatment is most effective when applied soon after cutworms have hatched. Only a small acreage of Ontario corn has cutworms problems any one year. For this reason, and because corrective sprays are available, granular treatments applied at planting time are not recommended.

If seedling corn is attacked and the cutworms are small, apply one of the following treatments in 400 L of water per hectare at the seedling (2- to 5-leaf) stage when damage first appears. Cutworms are most active in the evening and treatments are best applied at this time.

Table 20. Cutworm Control[1]

Insecticide	Product / ha
Ambush 500 EC[2]	225-300 mL
Lorsban 4 E	2.4 L
Ripcord 400 EC	175 mL

E or EC (Emulsifiable Concentrate)

[1] Seedling stage only.

[2] Read the label. Do not disturb the soil for 5 days after application.

Armyworm Because weed-infested corn is attractive to armyworm moths for egglaying, eliminate grasses and weeds from the corn crop. The result will be less armyworm damage to corn (See Ontario Ministry of Agriculture and Food Publication 75, *Guide to Chemical Weed Control*). When army worms move into corn fields, spray the border rows and adjacent cereals, pasture, or hay crops. Refer to Armyworms in Cereals section for more information.

Potato Stem Borer This pest of corn is more severe in the eastern counties of Prescott, Glengarry, Russell, Stormont, Carleton, Dundas and Renfrew, but infestations have been found throughout Ontario.

Seedling corn is destroyed by larvae (pinkish worms 4 cm long when mature) that bore into the base of plants just below or above ground level. The leaves of infested plants wilt and turn brown from the tips downward. Seedlings up to 40 cm high wither and die. Such plants break off at ground level when pulled. The worm may be found in the stalk or in the soil near the base of the plant. The larvae move to corn in late May or early June from grassy field borders.

At present there are no effective insecticides to control the potato stem borer in the corn. To reduce potato stem borer infestations, maintain weed-free fields and borders by plowing, cultivation and with the use of herbicides as outlined in OMAF Publication 75, Guide to Chemical Weed Control.

The primary weed hosts are perennial grasses and these must be killed in the fall or early enough in the spring to prevent the survival of borers. Herbicide treatments later than May 1st will probably do more harm than good. Evidence suggests that such treatments fail to kill borers but cause them to move to corn sooner. Where the potato stem borer has been troublesome in the past, doubling the plant stand by over-planting the border rows can help by compensating for seedling mortality.

Corn Leaf Aphid These small dark aphids do not overwinter in Ontario. Each year they are carried into the province by air currents. Populations of 400 or more per plant, especially under dry conditions, may be economically important. See OMAF Factsheet, *Corn Leaf Aphid*, Agdex 111/622.

White Grubs The larvae of June beetles have plump, white bodies with large brown heads and six prominent legs. They are found in a "C"-shaped position in the soil near the roots of plants. The adults lay their eggs in sod and white grubs are therefore a problem in corn following sod, particularly in run-down fields or pastures. When such fields are plowed, the partly grown larvae can be found, especially if the sod is broken apart and examined carefully.

Sap Beetles They are small dark beetles about 6 mm long with two yellow spots on each wing cover. These beetles are often numerous in corn fields but do not cause significant damage. For more information see Ontario Ministry of Agriculture and Food Factsheet, *Sap Beetles on Raspberries, Tomatoes and Corn*, Agdex 675.

Slugs are legless creatures (mollusks) that glide along on a path of mucus. This mucus dries out and can be seen in the daytime as a shiny trail over the leaves and soil. Slugs feed on the lower leaves of the corn, especially in the areas between the veins. This feeding often causes the leaves of corn to split lengthwise. If mucus trails or split leaves are seen, then look on the ground near the damaged plants. The slugs will be found resting during the day under stones, clods, and plant debris. The most troublesome slug in corn is the gray garden slug which is 1 to 2 cm long, gray, legless and slimy.

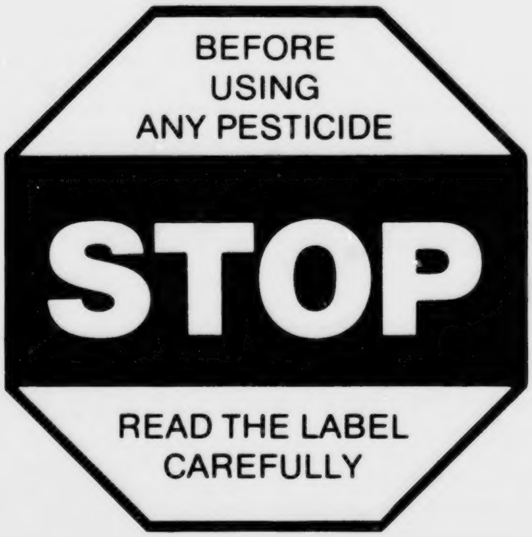
Damage to corn is most serious in May and June before the plants are well established. Treatments with a molluscicide are too expensive to be practical in field corn. Slugs are very dependent on moisture and organic matter on or near the soil surface. Slugs are most likely to be a problem on wet fields, following late spring plowing of red clover and with minimum tillage. See OMAF Factsheet, *Slugs*, Agdex 610.

Insects in Stored Grain

Stored Grain Insects — Surveys have shown that stored grain in county elevators and on farms in Ontario have the heaviest insect infestations of any region in Canada. **This situation must be corrected.** See section *Insects in Farm Stored Grain* under Cereal Crops, Insect Section.

WEED CONTROL IN CORN

For weed control recommendations see OMAF Publication 75, *Guide to Chemical Weed Control.*



FORAGE CROPS

Forages, as hay or pasture, occupy 1.7 million hectares or approximately 38% of the improved land in Ontario. In addition to providing economically much of the protein and energy for ruminant livestock, forages are also recognized as a valuable crop in soil conservation.

CROP MANAGEMENT

Soils for Forages Forages in general are adapted to a wide range of soil types and conditions, but each species has its own requirements for optimum production and persistence. Most species prefer well drained alkaline soils, while other species are less demanding. See the section on species description, and select legumes and grasses suited to your soil conditions. Some soil characteristics such as drainage or pH, can often be changed to suit the requirements of a desirable species such as alfalfa.

Forage Mixtures Forages are usually sown as mixtures of legume and grasses. The legumes contribute high protein, the ability to yield well without added nitrogen, and with some species, excellent drought tolerance. Grasses are more tolerant of adverse conditions and with their persistence, give insurance against winterkill. Under good management a simple mixture of one adapted legume and one compatible grass is usually most productive. In some long-term pasture situations, more complex mixtures may be advisable. For specific purposes and situations seeding of a pure stand of a legume or a grass may be recommended. Pure stands of legumes may be used for production of very high protein feed. Pure stands of grasses may be used where no legume is well adapted to either soil conditions or the intended management of the forage.

Seed Quality Quality seed is particularly important when establishing a perennial crop. Sow certified #1 seed to be sure of variety, germination standard, and reasonable freedom from weed seeds.

Legume Inoculation Legume seed should be inoculated with rhizobium bacteria before sowing. Seed coated in the current season is a good method of inoculation. Each legume species requires its own specific strain of rhizobium for proper nodulation. If the legume being planted has never been grown on the field before, proper inoculation is vital to a successful stand. Since inoculant must be alive, note the expiry date and handling precautions on the packet.

Time of Seeding Chance of successful establishment is highest with early spring seedings. Summer seeding, no later than mid-August, can succeed if moisture is adequate for germination. Legumes seeded in September or October rarely survive the winter. September seeding of grasses may be successful.

Seeding Rates The amounts of seed recommended in Tables 23, 26, 31, 32, 37 and 38 are intended for average to good conditions. When seeding early on a fine firm seedbed, particularly if band seeding, these rates may be reduced by 25%. When coated seed is used, do not reduce these rates because coated seed contains fewer seeds per unit weight.

Depth of Seeding Forage seeds should be seeded shallowly at a depth of 1 cm. Percent germination drops off rapidly if forage seeds are planted over 2 cm deep.

Direct Seeding or Use of Companion Crop Research has shown that in many situations, direct seeding without a companion crop will establish the best forage stands. Direct seeding eliminates the competition for light, moisture and nutrients from the companion crop. One or two cuts of forage are possible in the seeding year. Weeds are the greatest threat to success in direct seeding. Refer to OMAF Publication 75, *Guide to Chemical Weed Control* and to OMAF Factsheet, *Successful Forage Establishment*, Agdex 120/22.

Fertilizers Placement of fertilizer containing phosphorus in a band 3 to 5 cm below the seed promotes rapid seedling growth. Established forages required adequate fertilization for yield and persistance. Refer to the section on Fertilizer for Forages.

Harvest Management Optimum harvest dates for forages are a compromise between needs for yield, quality and persistence. As the crop matures, dry matter yields and persistence increase but digestibility and % protein decrease. The general recommendation is to harvest at bud to 1/10 bloom for legumes, and at boot to heads emerging stage for grasses. Avoid harvesting legumes during the critical harvest period. A final cut may be taken after the critical harvest period if additional feed is required. However, it is preferable to leave fall growth unharvested to catch snow for winter insulation.

For good winter survival legumes in particular require a period of growth in late summer - early fall without harvest. This "rest" allows plants to build up root energy reserves for winter survival and vigorous spring growth. The "critical fall harvest period" for alfalfa and trefoil varies with the length of the growing season. Changes in the timing of the critical fall harvest period with location in the province are shown in Figure 2 for alfalfa. In Northern Ontario, the period shown for alfalfa may also be applied to trefoil. In Southern Ontario, the critical period for trefoil is about 10 days earlier than for alfalfa at any given location.

Conserving Forage as Hay Fresh grass and legume forages are conserved in various forms for storage and feeding during the winter months. With good management, drying long hay down to 16 to 18% moisture, either in the field or supplemented with artificial barn drying, can conserve most of the yield and quality of the standing forage. In recent years, drying agents and wet-hay preservatives have come on the market, providing additional aids to successful haymaking.

Field losses, including those caused by mowing, respiration, conditioning, raking and baling, reduce yield by at least 20%, even in the absence of rainfall. Mowing losses are greater with a flail-type than with a cutter-bar or rotary mower. Prolonged field drying increases respiration losses (up to 4% of total yield per day) and exposes hay to weathering and rainfall losses. Rainfall is most damaging to digestibility and palatability as well as to yield when it falls late in the drying cycle. Mechanical conditioning usually accelerates drying, especially on first cut crops, which tend to be thicker-stemmed, but can also increase vulnerability to rainfall damage and shattering losses on raking or baling. Raking losses increase as moisture content decreases, particularly below 40% moisture. Baler pick-up and chamber losses can be reduced by raking light windrows together, and by travelling at maximum ground speed. Baling losses with large round balers can exceed those with rectangular balers. Legumes are more susceptible to losses than are grasses, whether due to rainfall or to mechanical practices such as tedding, raking, and baling.

Drying agents such as potassium carbonate, which are applied in liquid form at the time of cutting, have been shown to reduce drying time by up to a full day when the following rules are observed: (a) Apply to legume-dominant stands only, as drying agents do not work on grasses; (b) Be generous with the recommended water volume, because the water acts as a carrier, to distribute the product throughout the forage. Uneven distribution can result in hot spots, from which mold will spread in baled hay; (c) Lay the cut forage in a wide windrow, to reduce windrow resistance to water loss and allow the product to work; (d) Be ready to harvest when the hay is ready, to avoid overdrying and leaf loss; and (e) Remember that a drying agent won't compensate for bad weather or poor harvest management.

Preservatives, which may be applied in liquid or powder form at cutting or more commonly at baling, allow the safe conservation of hay baled in excess of safe baling moisture. Because the last few percent moisture are the most difficult to remove, a product which enables baling at 22 or 25% moisture can reduce field drying time by half a day or more, reducing exposure to rainfall damage and lessening leaf loss at baling. Propionic acid-based preservatives have been found to be most reliable, provided that care is taken in application, as outlined above.

Bacterial Silage Inoculants The application of a bacterial silage inoculant to alfalfa forage at 50 to 65% moisture often increases the rate of fermentation and the degree of acidification of the silage. This can improve silage quality and increase dry matter recovery. There is some indication that the application of an inoculant will reduce the conversion of plant proteins to soluble forms of nitrogen and to ammonia. Silage stability in the presence of air, animal intake, and animal performance may be improved. Bacterial silage inoculants are dried or inactive cultures of lactic acid bacteria. They usually contain *Lactobacillus plantarum* alone or in combination with other bacterial species. When applied to the forage, these bacteria grow and produce lactic and acetic acids. The product should supply at least 100,000 live bacteria (colony forming units) per gram of forage, when applied at the recommended rates. Products which are applied as a liquid solution often are more effective than dry powders.

The application of a bacterial silage inoculant will not overcome the effects of poor ensiling practices or poor weather conditions. The products are most effective when combined with good silo management and top quality forage.

LEGUMES

ALFALFA

Alfalfa based mixtures are widely recommended because they produce higher yields of hay, silage or green chop than any other mixture. For high yields and persistence, alfalfa mixtures require well drained soils. Adequate fertility and proper cutting management are also required. Under these conditions, alfalfa mixtures should be highly productive for three to four years.

The alfalfa varieties are divided into two groups based on their fall growth habit. The amount of fall growth reflects the variety response to shortening daylengths and cooler temperatures in the fall. As the daylength gets shorter, Iroquois-type varieties grow less following the last cutting compared to Saranac-type varieties. In other words, Iroquois-type varieties show somewhat greater fall dormancy than do Saranac-type varieties. There are no consistent differences in yield or persistence between the two groups.

There are no significant differences in protein level between alfalfa varieties. The major factor influencing protein levels of alfalfa is the date of harvest. As the plant matures, the percentage of protein decreases. Attempts to breed varieties with a higher protein level have resulted in higher protein, but unacceptable lowering of yields.

When used in pasture mixtures, alfalfa is useful for short-term stands only, since it will usually thin out in two or three years under grazing. On heavy clay loam soils with poor internal drainage, alfalfa often does not persist well because of heaving, and other legume species may be more adapted.

MANAGEMENT

1. Alfalfa based mixtures may be seeded with or without a companion crop. Where forage yields are required in the seeding year, seed direct, without a companion crop. If annual weeds are a problem, they must be controlled with herbicides or clipping. If grain or straw are required, the preferred companion crop is oats. The seeding rate should be 60 kg/ha or less. Winter wheat is not recommended as a companion crop for seeding alfalfa.

Where forage establishment is a problem due to lodging, drought etc. consider harvesting the cereal crop at the heading to milk stage for silage or when knee-high by controlled grazing.

2. To obtain feed with high digestibility and protein without sacrificing persistence, cut at the first flower stage.

3. Overgrazing pastures will kill alfalfa stand. Rotational or strip grazing with four to five week rest periods improves the persistence of alfalfa.

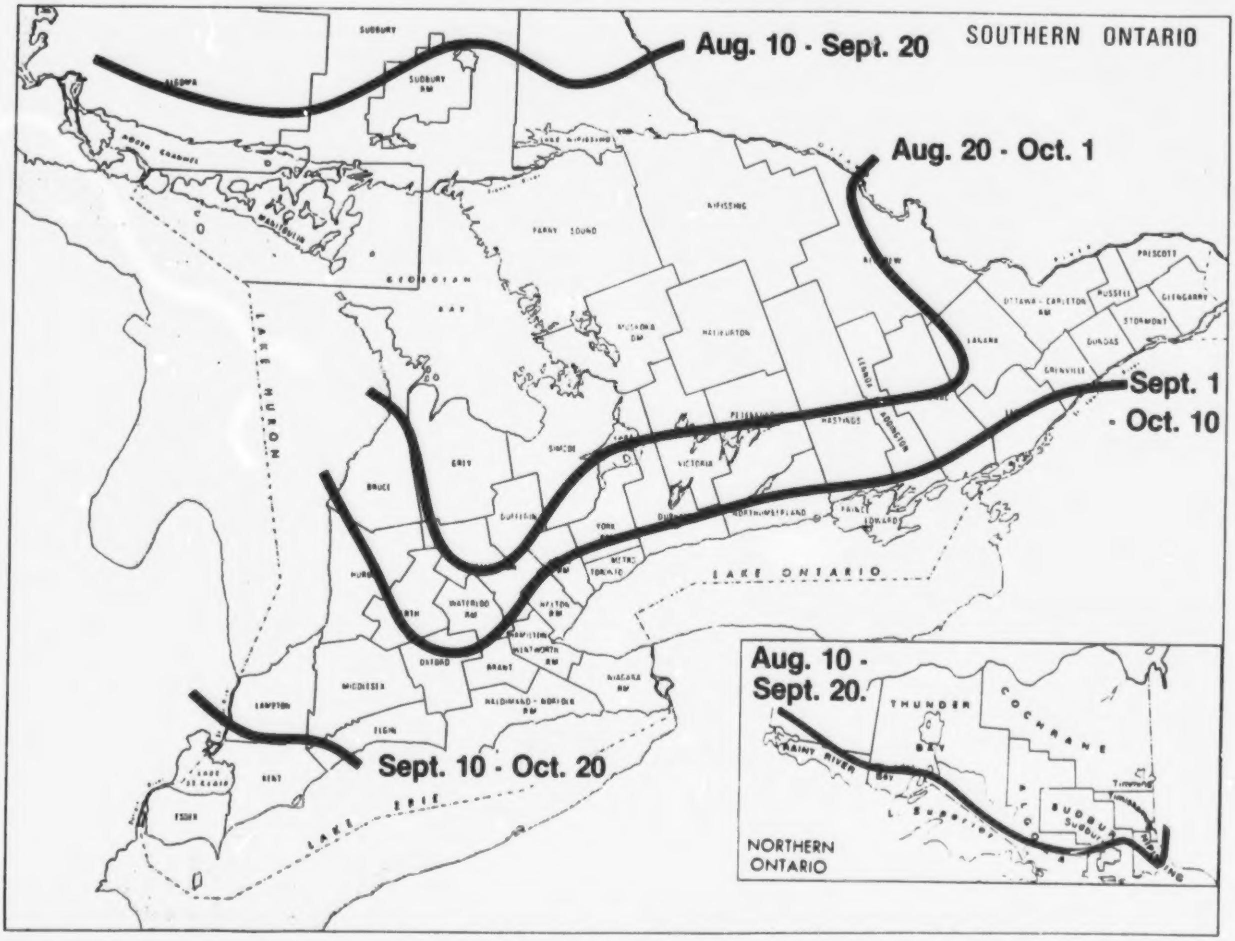
4. For high yields and good persistence of alfalfa, adequate phosphorus and potassium, from either the soil or applied fertilizer, are required. Potassium is particularly important for persistence. See the section, Fertilizer for Forage Crops.

5. Alfalfa is particularly sensitive to cutting or grazing during September and October. Persistence and yield in the following year can be severely reduced if alfalfa is harvested during the critical fall period.

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

Figure 2. Critical Fall Harvest Period for Alfalfa


Aug. 10 - Sept. 20
SOUTHERN ONTARIO
Aug. 20 - Oct. 1
Sept. 1 - Oct. 10
Sept. 10 - Oct. 20
LAKE HURON
GEORGIAN BAY
LAKE ONTARIO
LAKE ERIE
Aug. 10 - Sept. 20.
THUNDER BAY
COCHRANE
NORTHERN ONTARIO

To ensure persistence and succeeding yields, do not harvest alfalfa during the critical harvest period shown on the map for each region.

BEFORE
USING
ANY PESTICIDE

STOP

READ THE LABEL
CAREFULLY

Table 21. Recommended Alfalfa Varieties (Saranac-type Fall Dormancy)

			Disease Reaction			
	Yield (% of Saranac)		Verticillium	Phytophthora	Bacterial	
Variety	S. Ontario	N. Ontario	Wilt	Root Rot	Wilt	Distributor[1]
Acclaim	98	—	S	MS	MR	Otto Pick & Sons Seeds
Admiral	101	—	MS	MR	MR	Otto Pick & Sons Seeds
Alouette	98	109	S	S	MR	Otto Pick & Sons Seeds
Anchor	99	98	S	S	MR	Oseco Inc.
Angus	98	101	S	S	R	Public
Apica	104	105	S	S	MR	United Co-operatives of Ontario
Apollo II	98	—	MS	MR	MR	Oseco Farm Seed Centre
Armor	102	—	S	MR	MR	Oseco Inc.
Arrow	105	—	MR	MR	MR	Otto Pick & Sons Seeds
Award	101	—	S	S	MR	Speare Seeds
Blazer	102	—	S	MS	R	Oseco Inc.
Ceres	100	91	S	S	MR	Speare Seeds, King Agro Inc.
Citation	103	107	S	S	MR	Mapleseed Inc.
Classic	100	95	S	S	MR	United Co-operatives of Ontario
DK-135	101	—	MS	MS	MS	Dekalb Canada
Eagle	100	—	MS	MS	R	Maple Leaf Mills Ltd.
Excalibur	103	—	MS	S	MR	United Co-operatives of Ontario
Hunter	99	102	S	S	MR	Rothwell Seeds
Husky	102	—	S	MS	MR	Oseco Inc.
Maxim	100	—	MS	S	MR	Otto Pick & Sons Seeds
Pacer	99	97	S	MS	MS	Bishop Seeds, Oseco Inc.
Peak	100	105	S	MR	R	Oseco Farm Seed Centre
88	99	—	MS	MS	MR	Mapleseed Inc.
532	102	99	S	S	R	Pioneer Hi-Bred
Preserve	102	—	S	MS	MR	Northrup King
Primal	103	101	S	S	R	King Agro Inc.
Regal	101	96	S	S	R	United Co-operatives of Ontario
Saranac	100	100	S	S	MR	Public
Spectrum	100	104	S	MS	MR	Labonte Seeds
Thor	100	99	S	S	R	Northrup King Seeds
Trident	99	95	S	R	MR	PAG Seeds
Trumpetor	98	99	MS	S	MS	Northrup King Seeds
Turbo	101	103	S	MR	MR	Otto Pick & Sons Seeds
Vista	100	97	S	S	MR	Otto Pick & Sons Seeds
WL 316	101	—	MS	S	MS	King Agro Inc., Speare Seeds

Average yield of Saranac in Southern Ontario trials 12.4 t/ha, in Northern Ontario trials 7.8 t/ha.

R — Resistant (more than 50% resistant plants); MR — Moderately resistant (36 to 50% resistant plants)
MS — Moderately susceptible (21 to 35% resistant plants)
S — Susceptible (less than 21% resistant plants)

[1] See Distributor Address in General Information Section.

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Table 22. Recommended Alfalfa Varieties (Iroquois-type Fall Dormancy)

Variety	Yield (% of Iroquois) S. Ontario	Yield (% of Iroquois) N. Ontario	Disease Reaction Verticillium Wilt	Disease Reaction Phytophthora Root Rot	Disease Reaction Bacterial Wilt	Distributor[1]
Algonquin	98	100	S	S	R	Public
Ambassador	105	—	MS	MR	MR	Otto Pick & Sons Seeds
120	105	102	S	MR	R	Dekalb Canada
Glory	103	97	S	S	MR	Speare Seeds
Iroquois	100	100	S	S	R	Public
Magnum	101	100	S	S	MR	Funk Seeds
Noble	102	—	S	S	MR	United Co-operatives of Ontario
OAC Minto	103	104	S	S	MR	Speare Seeds, Bishop Seeds
Oneida VR	102	—	MR	R	MR	Otto Pick & Sons Seeds
524	103	90	S	S	MS	Pioneer Hi-Bred
526	103	93	S	S	R	Pioneer Hi-Bred
Thunder	101	94	S	MR	MR	Oseco Farm Seed Centre
Titan	98	98	S	S	MR	Oseco Inc.
Valor	100	97	S	S	MR	Rothwell Seeds
Vernal	99	96	S	S	MR	Public
WL 222	101	—	S	MS	MR	King Agro Inc., Speare Seeds
Weevlchek	100	92	S	S	R	United Co-operatives of Ontario

Average yield of Iroquois in Southern Ontario trials 12.3 t/ha, in Northern Ontario trials 7.4 t/ha.

R — Resistant (more than 50% resistant plants); MR — Moderately resistant (36 to 50% resistant plants)
MS — Moderately susceptible (21 to 35% resistant plants)
S — Susceptible (less than 21% resistant plants)
See Distributor Address in General Information Section.

Table 23. Recommended Alfalfa Based Mixtures

Components	Seeding Rate[1] kg/ha	Use Recommendation
Alfalfa (alone)	13	Use only on well-drained fertile fields where alfalfa persists well. Easier to cure as silage than as hay. Gives high protein feed when harvested at the bud stage.
Alfalfa Timothy	13 1	Harvest for silage or hay. Timothy is included for stand insurance and weed control in areas of the field less suited to alfalfa. Gives high protein feed harvested at the bud stage.
Alfalfa Timothy	13 4	Harvest for hay or silage. Timothy provides stand insurance in case of alfalfa winterkill. Easier to cure for hay than the above mixtures. Protein % will be lower than above mixtures, when cut at similar maturity.
Alfalfa Bromegrass	11 9	Harvest for hay or silage. Preferred over alfalfa — timothy on dry soils, or areas having over 3100 heat units. Similar quality and curing characteristics to the above mixtures.
Alfalfa Orchard	11 6	Harvest for early silage or hay, or pasture. Use later maturing orchard grass varieties and early alfalfa varieties. Must be cut or grazed early to obtain good protein and digestibility. More grass in 2nd and 3rd cut than from timothy or brome mixtures.
Alfalfa Orchard Ladino	9 9 2	Harvest as pasture. High fertility and good grazing management needed for top production. Alfalfa gives insurance against drought, but requires rotational grazing to persist satisfactorily. See white clover-orchard mixture in *White Clover* section.
Alfalfa Ladino Timothy Bromegrass	9 2 4 9	Harvest as pasture, or as 1st cut hay with aftermath pastured.
Alfalfa Ladino Orchard Bromegrass	9 2 3 9	Harvest as pasture, or as 1st cut hay with aftermath pastured. This mixture will provide earlier feed, and a higher % grass in aftermath than the mixture above.

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[1] *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used. On farms where these mixtures result in stands with too much grass, reduce the grass seeding rate by up to 50%.*

BIRD'S-FOOT TREFOIL

Bird's-foot trefoil is a legume well suited for long term pasture production. It tolerates grazing better than other legumes and does not cause bloat. By reseeding naturally, trefoil pasture fields can remain productive for 10 or more years. This feature is particularly useful on steep, rolling land where frequent reseeding is undesirable. Trefoil is also adapted to a wide range of soil drainage conditions, and will persist on soils too acid for red clover or alfalfa production.

Trefoil can also be harvested for hay or silage. The more upright varieties are easier to harvest for stored feed than the low growing Empire variety. Trefoil stands thin out much more rapidly under a harvest system that does not allow some seed set and thus natural reseeding.

On well drained fertile soils of pH over 6.0, trefoil will produce for stored feed about 60% of the yield of a full stand of alfalfa. Only 2 cuts/year can be expected from trefoil in Southern Ontario because of slower growth in the spring and slower aftermath compared to alfalfa. Trefoil stands often do not reach maximum productivity until their second year of production.

Management

1. Trefoil is best established using conventional seedbed preparation. Because trefoil has low seedling vigour, it should be seeded direct, rather than with a companion cereal crop. Seed as early in the spring as the field is workable, at a depth of no more than 10 mm. Packing after seeding improves germination. Banding a fertilizer containing phosphate at planting improves seedling vigour.

2. On fields which have not previously grown trefoil, inoculation of the seed with fresh rhizobia bacteria is essential. Even on fields that have grown trefoil before, inoculation is a good practice. Be sure that the inoculant is specific for trefoil.

3. Weeds in direct seeded trefoil will need to be controlled, either with a herbicide or by clipping. Refer to Publication 75, Guide to Chemical Weed Control, for herbicide recommendations.

4. For hay or silage, the first cutting should be made at the early bloom stage. The second cut should come off at one half to full bloom, prior to the critical fall rest period.

5. For pasture, allow trefoil to reach a height of 15 to 20 cm before initial spring grazing. For maximum production, use rotational rather than continuous grazing.

6. Heavy grazing or cutting of trefoil during the critical fall harvest period (See Figure 2) will reduce yield the following year. In Southern Ontario, the period during which trefoil should not be harvested is about 10 days earlier than it is for alfalfa at any given location. In Northern Ontario, the period shown for alfalfa may also be applied to trefoil.

Bird's-Foot Trefoil Variety Selection

Two types of trefoil, a hay type and a pasture type are recommended in Ontario. Differences between types are very significant, and should be carefully considered in selecting a variety.

The hay types, represented by Viking and Maitland, have more erect growth, are earlier flowering and produce aftermath more rapidly. While they have less tolerance to poor drainage and grazing than pasture type varieties, they are still superior to alfalfa in these respects.

Pasture types, represented by Leo and Empire, have greater tolerance to poor drainage and pasturing. They are more winterhardy and stands last longer. Their prostrate growth habit makes them more suitable for pasturing than for harvest as stored feed.

Table 24. Recommended Bird's-Foot Trefoil Varieties

	First Flower						
Variety	**(Guelph)**	**(Kapuskasing)**	**Major Use**	**Regrowth**	**Variable Drainage Tolerance**	**Hardiness**	**Distributor[1]**
Viking	June 15	June 25	Hay	Medium	Fair	Good	Public Variety
Maitland	June 16	June 27	Hay	Medium	Fair	Good	Mapleseed Inc. Otto Pick & Sons Seeds
Leo	June 23	June 30	Pasture or Hay	Medium to Slow	Good	Excellent	Public Variety
Empire	July 1	July 7	Pasture	Slow	Excellent	Excellent	Variety

[1] *See Distributor Addresses in General Information section.*

Table 25. Bird's-Foot Trefoil Variety Yields

Variety	**Yield (as % of Leo) Southern Ontario %**	**Northern Ontario %**
Leo	100	100
Empire	99	96
Maitland	100	92
Viking	100	92

Average yield of Leo in southern Ontario trials 8.8 t/ha; in northern Ontario trials 5.9 t/ha.

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

Table 26. Recommended Bird's-Food Trefoil-Based Mixtures

Components	Seeding Rate[1] kg/ha	Use Recommendation
Trefoil Timothy	9 2	For long term pasture, hay or silage. Match maturity of timothy variety to trefoil maturity. Timothy gives low summer production under hot dry conditions.
Trefoil Bromegrass	9 4	For long term early pasture and hay or silage. Graze early to reduce competition from bromegrass. Good yields are produced in the fall. Bromegrass has only fair tolerance to poor drainage.
Trefoil Meadow Foxtail[2]	9 10	For extra early pasture production. Graze early to reduce competition from foxtail. Tolerates poor drainage well.
Trefoil Tall Fescue[3]	8 10	For good pasture production throughout the season. Good yield and quality throughout the fall.
Trefoil Creeping Red Fescue	8 6	For good summer and fall pasture production. Excellent quality for fall pasture.
Trefoil Orchard	8 4	For good early and mid-summer pasture production. Must keep orchard grass grazed down to reduce grass competition with trefoil. Orchard grass tolerates hot dry conditions, but not poor drainage. Later maturing orchard grass varieties are preferable.

[1] *For early seeding on a fine, firm seedbed. These rates may be reduced by 25% except where coated seed is being used.*

[2] *Use coated seed. It can be seeded through the grain seed box.*

[3] *Use endophyte-free seed.*

RED CLOVER

Red clover-based mixtures are short-term mixtures best used for stored-feed production. Red clover produces well in the year following seeding, but usually thins by the second harvest year and rarely survives for a third harvest year. Timothy is the best grass to use with red clover. Red clover is difficult to cure as hay, but makes excellent haylage. It is not recommended in pasture mixtures because of the bloat hazard and poor persistence.

Red Clover Types

Double-cut or medium red clover is the most popular type with farmers. It will flower in the seeding year and in the first and second cut in the succeeding years. The regrowth after cutting is strong and vigorous.

Single-cut or mammoth red clover is slower growing with larger stems and matures about two weeks later than the double-cut. It does not flower in the seeding year or in the slow growing, low yielding leafy aftermath in succeeding years.

Red Clover Variety Selection

The recommended double-cut varieties of red clover are somewhat more persistent in the second production year than is commercial Canadian double-cut, and are particularly recommended where stands will be harvested for more than one year.

Table 27. Red Clover Variety Yields

Variety	Yield (as % of Florex) Southern Ontario %, Year 1	Southern Ontario %, Year 2	Northern Ontario %, Year 1	Northern Ontario %, Year 2
Florex	100	100	100	—
Arlington	98	92	92	—
Lakeland	99	91	93	—
Ottawa	93	85	86	—
Prosper I	99	94	98	—

Average yield of Florex in southern Ontario trials, year 1, 9.4 t/ha; year 2, 10.2 t/ha; in Northern Ontario trials, year 1, 6.5 t/ha.

Table 28. Recommended Double-Cut Red Clover Varieties

Variety	First Flower (Guelph)	First Flower (Kapuskasing)	Regrowth	Variable Drainage Tolerance	Distributor[1]
Arlington	June 15	June 29	Medium	Good	Public variety
Florex	June 18	July 2	Medium	Good	Northrup King Seeds Otto Pick & Sons Seeds Mapleseed Inc.
Lakeland	June 18	July 2	Medium	Good	Public variety
Ottawa	June 18	June 29	Medium	Good	Public variety
Prosper 1	June 18	July 2	Medium	Good	King Agro Inc.

[1] *See Distributor Addresses in General Information section.*

Table 29. Recommended Red Clover-Based Mixtures

Components	Seeding Rate[1] kg/ha	Expected Life (years)	Use Recommendation
Red Clover	11	1	Short-term hay, seed and/or plow-down crop. Plow in the seeding or after the first production year. Follow with corn, a row crop or cereals to utilize the nitrogen contributed by the clover.
Red Clover Timothy	7 6	1 to 2	For short-term stand of hay. When clovers disappears, plow, or fertilize with nitrogen in order to maintain production.
Red Clover Alsike Timothy	7 2 6	1 to 2	For short-term hay. Less clover can be expected in the second year. When clovers disappear, plow, or fertilize with nitrogen in order to maintain production. Alsike is more tolerant of acid soils and poor drainage.

[1] *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used.*

Red Clover Plow-down

Plow-down red clover is red clover seeded with a cereal crop and plowed down in late fall of the establishment year or early the next spring. When used in this manner a full stand 15 cm in height at fall plowing can contribute excellent soil tilth and substantial nitrogen to the following crop (see *Nitrogen Adjustment for Legumes Plowed Down*). Generally double-cut red clover produces more top-growth than single-cut.

There appears to be no advantage to sowing named vs. common lots of red clover, or to leaving the stand down for more than one year before plowing it under. On land with no history of red clover, inoculation of the seed with the appropriate Rhizobium culture will ensure the nitrogen contribution.

Red clover has a vigorous seedling which establishes easier than alfalfa. When establishing red clover under spring grain, it is preferable to seed early to avoid lodging of the grain crop and harvest problems. Red clover seed may be broadcast directly or included in the spring application dry or liquid nitrogen on winter wheat.

WHITE CLOVER

White clover mixtures perform best as pastures, particularly in areas where moisture is plentiful and winterkilling is not a problem. They are difficult to cure as hay. Ladino is the large tall-growing type of white clover, and is the type of white clover recommended in Ontario. It tolerates variable drainage conditions. Because it flowers in early June and regrows rapidly, it performs well in combinations with orchard grass to give an early maturing mixture. Including an early productive grass such as orchard grass in a white clover based pasture mixture can help to reduce the bloat hazard.

Management

1. Control grazing in autumn to leave protective cover of grass leaves on overwintering creeping stems of ladino.
2. Controlled grazing management helps the stand remain productive for a period of years.

Table 30. Recommended White Clover Varieties

Variety	Distributor[1]
California Ladino	Public
Merit	
Sacramento	Tib Szego Associates Ltd.

[1] See Distributor Addresses in General Information section.

Table 31. Recommended White Clover-Based Mixtures

Components	Seeding Rate[1] kg/ha	Expected Life (years)	Use Recommendations
White Clover (Ladino type) Orchard	2 9	3	For pasture use where white clover is adapted. High fertility, adequate moisture, and good management required for top production. In dry areas add alfalfa. See alfalfa ladino orchard mixture in Table 23.

[1] *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used.*

GRASSES

Generally, legume grass mixtures are more productive than grasses grown alone. However, pure grass stands may be more productive than legumes on poorly drained soils, under acid soil conditions, or under climatic or management conditions unfavorable to legumes.

Orchard grass, bromegrass, timothy and mixtures of these can be used in areas where early pasture is required.

When cut at the "heads emerging" stage for stored feed, grasses are as high in digestible energy as legumes. If fertilized with nitrogen their crude protein content may range from 12 to 15%. Reed canary grass should be used on very poorly drained areas when long-term stands are desired. All grass stands require nitrogen, phosphate and potash to be productive. (See *Fertilizers for Forage Crops*).

Management

1. Successful seeding of pure grass can best be obtained by seeding in early spring. Use a complete fertilizer (Nitrogen, Phosphate and Potash) at seeding time.
2. Harvest grasses at the "heads just emerged" stage of growth for top quality stored feed. For maximum stand persistence, harvest at heading is recommended.
3. Apply recommended rates of nitrogen early each spring and after each cutting or grazing. See Table 40.
4. Apply phosphate and potash each fall at rates indicated by soil test. See recommendations in *Fertilizers for Forage Crops*.

Table 32. Recommended Pure Grass Seeding Rates

Pure Stand of	Seeding Rate kg/ha
Reed Canary	9
Brome	11
Timothy	9
Orchard	9

TIMOTHY

Timothy is the most widely used forage grass in Ontario. It grows under a wider range of environments than any other grass used, and is easy to establish and maintain. Alfalfa-timothy mixtures are among the most popular and productive mixtures for stored feed. Timothy is well adapted to the heavier soil types and variably drained fields. Cut for hay at the heading stage, timothy is a high-yielding quality grass. Like all grasses, in a mixture it contains about half the crude protein of alfalfa. For pasture or hay aftermath, timothy is a lower producer than orchard or brome. Palatable and high-yielding in the spring, it grows back slowly after cutting or grazing, and most varieties produce relatively poor growth during the dry midsummer. However, since timothy adds stand insurance, small to moderate amounts are useful when making new seedings with legumes.

BROMEGRASS

This grass species is important for early and late cut hay. When harvested at the recommended "heads emerged" stage, it is higher in digestibility and much earlier maturing than timothy. As bromegrass advances in maturity, its digestibility decreases at a slower rate than other grasses. Bromegrass produces slightly more aftermath than timothy and combines well with alfalfa in legume-grass mixtures.

For early pasture bromegrass is excellent. Used in mixtures it permits early grazing in the spring and produces good growth in the fall. Use only recommended varieties. Seeding must be shallow, no deeper than 1 - 2 cm.

ORCHARD GRASS

This grass is an early maturing forage that grows rapidly under a high nitrogen fertilization program. It is cut for stored feed when the heads are just emerging from the boot. All varieties are adapted to silage and pasture mixtures. The later varieties will combine better with alfalfa for hay or hay- pasture mixtures.

Orchard grass grows back rapidly after cutting or grazing. It is our best grass for aftermath production during the hot, drier summer period. It will reduce the bloating effect of alfalfa and the clovers when grown in mixtures. For pasture, the maturing stems and heads should be clipped in late May or in early June to maintain leafy, palatable growth.

Orchard grass requires well-drained soils to perform adequately. Surface drainage is necessary as ice conditions or flooding will kill orchard grass.

REED CANARY GRASS

This grass species tolerates excessive moisture and is highly productive for long-term hay or pasture on poorly drained soils, or areas subject to prolonged periods of flooding. It is also adapted to dry upland soils. For stored feed reed canary grass is more acceptable to livestock when stored as silage or haylage, rather than dry hay, due to its coarse growth habit.

Reed canary grass is a good pasture producer when grazed heavily enough to prevent heading.

In the past, most reed canary grass varieties contained alkaloids which have been shown to have a significant negative effect on livestock performance. All the varieties now recommended in this publication are free of the undesirable tryptomine and carboline alkaloids.

CREEPING RED FESCUE

Creeping red fescue establishes well on a wide range of soil types and will establish plants also on well-fertilized subsoil. It spreads vigorously on ditch banks with a solid underground root system. Such roots hold the soil from underneath while the thick, fine, leafy top growth protects the soil surface against water movement. These characteristics, plus its low growth, make it very useful for stabilizing soils on ditch and creek banks and on grass waterways. Creeping red fescue survives well in long term pastures.

TALL FESCUE

Tall fescue is a coarse leafy grass useful in long-term pasture and in erosion control. It is adapted to most soil types, tolerant of imperfect drainage, and withstands animal traffic well. Recently, a seed-borne systemic fungus (an endophyte) has been linked to poor animal performance on tall fescue pasture. Endophyte-free seed is available and should be sown when tall fescue is seeded for pasture. Once introduced by infected seed, the fungus cannot be controlled in an established stand of tall fescue.

MEADOW FOXTAIL

Meadow foxtail is a long-lived perennial grass which resembles timothy in appearance and is well adapted to intensive pasture management. It performs well on poorly drained soils, has very early spring growth, and responds well to nitrogen. Mid-summer production during periods of high temperature and drought may be low. Seed is light, fluffy and hairy, and therefore, should be coated prior to seeding.

RYEGRASS

Ryegrass is a rapidly growing bunch grass that is adapted to a wide range of soil conditions. It is a useful species for mid to late season production and is very responsive to nitrogen fertilization. Two types of ryegrass are available and they differ remarkably in their growth habit. The

Italian ryegrasses are actually short lived perennials. However, under Ontario winter conditions, there is usually 100% winterkill. When grown as an annual, the Italian ryegrasses remain vegetative, producing a lush leafy growth that usually doesn't grow taller than 40 cm. It is an ideal pasture species and can be grazed as often as five or six times. The Westerwold type is a true annual. It will produce a variable number of seed bearing tillers depending on the variety. The Westerwolds varieties grow to 40-80 cm high making them suitable for pastures or hay crops. Feed quality decreases rapidly after heading. The dry matter content varies from 10-20% depending on the variety, maturity and season.

THE BLUEGRASSES

Two common bluegrasses in Ontario, Canada and Kentucky, grow on about one million hectares of permanent pasture land. Much of this pasture is low in production but can be improved by renovation, fertilization and weed control. The dense but shallow rooted bluegrasses produce lush, palatable growth during the springtime but low yields during the dry, hot midsummer in southern Ontario.

Properly fertilized and managed, their production can be markedly improved, especially in the cooler climate of northern Ontario. In pastures, they serve as a bottom grass that controls weed invasion, withstands close grazing and tramping, and creeps and fills in where other species thin out.

Table 33. Recommended Grass Varieties

	Heading Date				
Variety	(Guelph)	(Kapuskasing)	Aftermath Production	Tolerance to Variable Drainage	Distributor[1]
Timothy					
Salvo	June 16	June 22	Good	Good	SeCan member
Toro	June 20	July 3	Good	Good	Oseco Inc.
Basho	June 22	July 2	Good	Good	Public
Richmond	June 22	July 2	Fair	Good	Mapleseed Inc., Otto Pick & sons Seeds
Champ	June 23	July 1	Good	Good	Public
Itasca	June 25	July 3	Fair	Good	United Co-operatives of Ontario
Mariposa	June 24	July 2	Good	Good	United Co-operatives of Ontario
Timfor	June 28	July 3	Fair	Good	Northrup King Seeds
Climax	June 28	July 5	Fair	Good	Public
Winmor	June 29	July 6	Fair	Good	Northrup King Seeds
Bromegrass					
Baylor	June 10	June 26	Good	Fair	Oseco Inc.
Beacon	June 10	June 25	Good	Fair	Oseco Inc., United Co-operatives of Ontario
Blair	June 10	June 24	Good	Fair	Mapleseed Inc.
Bravo	June 10	June 25	Good	Fair	Otto Pick & Sons Seeds
Saratoga	June 10	June 24	Good	Fair	Public
Tempo	June 10	June 24	Good	Fair	Otto Pick & Sons Seeds
Orchard Grass					
Hallmark	June 2	June 15	Excellent	Poor	United Co-operatives of Ontario
Juno	June 2	June 15	Excellent	Poor	Mapleseed Inc., Otto Pick & Sons Seeds
Napier	June 8	June 16	Excellent	Poor	Oseco Inc.
Sumas	June 12	June 18	Excellent	Poor	Oseco Inc.
Kay	June 12	June 18	Excellent	Poor	Oseco Inc.
Reed Canary Grass					
Vantage	June 10	June 24	Excellent	Excellent	Oseco Inc.
Meadow Foxtail					
Dan	May 15	May 30	Good	Excellent	Oseco Inc.

[1] *See Distributor Addresses in General Information section.*

Table 34. Timothy Variety Yields

Variety	Yield (as % of Climax) Southern Ontario %	Northern Ontario %
Climax	100	100
Basho	98	103
Champ	99	108
Itasca	100	104
Mariposa	102	98
Richmond	98	102
Salvo	97	98
Timfor	101	105
Toro	97	100
Winmor	104	—

Average yield of Climax, southern Ontario trials 10.1 t/ha; in northern Ontario trials 7.2 t/ha.

Table 35. Orchard Grass Variety Yields

Variety	Yield (as % of Hallmark) Southern Ontario %	Northern Ontario %
Hallmark	100	100
Juno	100	98
Kay	101	103
Napier	101	96
Sumas	104	101

Average yield of Hallmark, southern Ontario trials 10.0 t/ha; in northern Ontario trials 6.7 t/ha.

Table 36. Bromegrass Variety Yields

Variety	Yield (as % of Baylor) Southern Ontario %	Northern Ontario %
Baylor	100	100
Beacon	98	104
Blair	96	—
Bravo	97	110
Saratoga	95	95
Tempo	93	103

Average yield of Baylor, southern Ontario trials 11.6 t/ha; in northern Ontario trials 8.8 t/ha.

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SPRING PASTURE

Autumn-seeded fall rye or **winter triticale** can be grazed for a short period in the spring, preferably after the stems start to form. Seed fall rye at 150 kg/ha, and winter triticale at 100-125 kg/ha. Keep stock off when wet. Another pasture or green chop crop (e.g. corn or sorghums) may follow the rye for summer feed in intensive programs.

SUMMER GREEN CHOP OR PASTURE

Sudan Grass Hybrids, Sorghum Hybrids, Sorghum-Sudan Hybrids Seed from mid May to early June at about 14 kg/ha in 18 or 36 cm drill rows. The crop is ready for green chop or grazing by late July-August. Do not graze before 75 cm high or during severe stress as **prussic acid poisoning** could occur. If frozen, allow three days following frost before grazing again to avoid prussic acid poisoning. Aftermath yields are moderate but high if warm moist weather prevails. Under good nitrogen fertility, these crops can produce large quantities of nutritious, palatable herbage. They are particularly useful on dairy farms to supplement normal pastures during August and September. These hybrids are not recommended in short season areas because of inconsistent yields and danger of prussic acid poisoning.

Cereals Seed any time in the season to produce pasture in six to eight weeks. Seed at 100 kg/ha. Graze when stems are forming. No aftermath can be expected.

AUTUMN PASTURE

Oats Seeded at 100 kg/ha between mid July and mid August, ready for grazing in six weeks.

Fodder rape Seed in early July at 1.7 kg/ha in 71 cm rows. May be seeded in solid stands, but yields are 25% lower. Pasture in late October. Makes good hog, sheep, or beef pasture. Taints milk.

Marrowstem kale Seed by early June on clean fields well supplied with nitrogen (85 kg/ha). Solid seedings at 7 kg/ha give good yields for grazing in August and September; 71 cm rows seedings for grazing in October and November. Kale is palatable to all classes of livestock. Moderate intakes will not produce off-favors in milk. The varieties **Maris Kestrel** and **Gruner Angiliter** are recommended. Gruner Angiliter is distributed by Otto Pick & Sons Seeds and Mapleseed Inc.

Fall rye or **Winter Triticale** Either species gives good fall pasture by October 1. Seed rye at 150 kg/ha and triticale at 120 kg/ha.

SILAGE CROPS

Corn is the most productive silage crop. Any of the cereals make satisfactory silage harvested by the early dough stage. The sudan grass, sorghum and sorghum-sudan hybrids can also be made into silage.

FORAGES FOR SOIL CONSERVATION

Most of the grass and the legume species used for livestock forages can be used for erosion control and soil conservation purposes to stabilize soil, to prevent weed infestation and to provide an attractive appearance. When selecting species or mixture consider the factors of permanence, adaptability to the particular location, moisture, soil characteristics, use of the area, frequency of mowing. Grasses with creeping root systems (rhizomous) are preferred to bunch grasses. Legumes contribute nitrogen. Recommended species and mistures are given in Table 38.

Table 37. Special Purpose Mixtures for Livestock

Use	Components	Seeding Rate kg per hectare	Comments
Horse pasture	Alfalfa	9	Early spring seeding is preferred.
	White clover	2	
	Timothy	5	
	Bromegrass	9	
	Kentucky bluegrass	5	
Horse paddock Dairy Holding Area	Tall Fescue	14	Early spring seeding is preferred. For exercise area only. Clip if necessary.

Table 38. Mixtures for Soil Conservation

Use	Components	Seeding Rate kg per hectare	Comments
Ditch banks	Trefoil (Empire Type)	13	Early spring seeding is preferred.
	Creeping Red Fescue	20	Apply 2 cm of straw as a mulch.
	Tall Fescue	45	Best results are obtained by seeding immediately after digging or reshaping. Late summer or early fall seedings are preferred. Mulch spring and early summer seedings with 2 cm straw to prevent drying out.
Waterways	Any of the Alfalfa or Trefoil based mixtures (Tables 23 and 26)		These mixtures can be used and harvested for stored-feed where standing water is not a problem and the slope not too severe. Otherwise the Trefoil-Fescue mixture or Tall Fescue should be used.
	Tall Fescue	22	Tall fescue is a tough sod forming grass which can withstand wear by livestock and farm machinery. It is recommended for erosion control on diversion terraces, grass, waterways, and farm pond dams.

FERTILIZERS FOR FORAGE CROPS

Nitrogen

Stands containing half or more legume do not require nitrogen fertilizers.

Grass stands containing less than one-third legume require large amounts of nitrogen. Where conditions permit, therefore, it is generally more profitable to reseed to mixtures containing legumes. It can be profitable, however, to fertilize grass stands consisting of productive species such as brome, orchard, or timothy. The use of nitrogen will also increase the protein level in the grass. The rates of nitrogen recommended for grass stands have been developed on the basis of the price of nitrogen relative to the value of hay (see Table 40). The first application for hay or pasture should be made as early as possible in the spring, followed by a second application after the first cutting and a third application after the second cutting. To avoid the danger of nitrate toxicity no more than 170 kg of N per ha should be applied at any one time.

Table 39. General Nitrogen Requirements-Perennial Forages

Crops	N Required kg/ha[1]
Legume or legume-grass at seeding - with or without companion crop	15
Unimproved pasture	50
Grass for seed	90
Hay or pasture - 1/2 or more legume	0
Hay or pasture - 1/3 to 1/2 legume	60
Hay or pasture - grass (less than 1/3 legume)	(See Table 40)

[1] *100 kg/ha = 90 lb/ac.*

Table 40. Nitrogen Requirement Table for Improved Grass Hay or Pasture

Value of Grass Hay @ 15% Moisture		Application No.[2]	Cost of Nitrogen Fertilizer - ¢/kg (¢/lb)			
			60 (27.2)	70 (31.7)	80 (36.3)	90 (40.8)
$/tonne	($/ton)		Nitrogen Requirement[1] (kg/Na/ha)			
30.00	(27.22)	1	95	75	69	45
		2	75	60	50	35
		3	60	50	40	30
50.00	(45.36)	1	130	125	115	105
		2	105	100	90	80
		3	85	80	70	65
70.00	(63.50)	1	150	140	135	130
		2	120	115	110	100
		3	95	90	85	80

100 kg/ha = 90 lb/ac.

[1] *All rates should be reduced by one third where the crop is to be harvested by grazing because of recycling through manure and urine. Where manure is applied to machine harvested forage, reduce the fertilizer application according to the amount and quality of manure (see Manure section in Soils).*

[2] *1. First application to be made prior to May 10.*
2. Second application to be made after the first cut.
3. Third application to be made after the second cut only if there is reasonable assurance of a third cut.

Phosphate and Potash

Phosphate and potash requirements for forages are given in tables 41 and 42. For information on use of these tables see *Soil Testing Section in Soils.*

When direct seeding on soils which require phosphate fertilizer, establishment may be improved by the placement of a high phosphate fertilizer 5 cm directly below the seed. Using a grain drill with fertilizer and grass seed attachments, this placement may be accomplished by drilling the fertilizer through the furrow opener and dropping the forage seed on a firm soil surface directly behind the furrow opener. Usually it is advisable to firm the soil surface immediately after seeding.

The timing of fertilizer application to established forage stands may influence the response obtained. Potassium, where required, is best applied after the last harvest prior to the fall rest period (see *Fall Management*). Phosphorus, if required may be applied with the potassium in the fall or applied separately in the spring or summer.

Table 41. Phosphate Requirements for Forages Based on OMAF Soil Tests

	At seeding with or without nurse crop		Forages at seeding-band seeded[1]		Established hay or pasture		Unimproved pasture	
Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[2] Required kg/ha	Rating	Phosphate (P_2O_5)[2] Required kg/ha	Rating	Phosphate (P_2O_5)[2] Required kg/ha	Rating	Phosphate (P_2O_5)[2] Required kg/ha
0-3		130		130		90		70
4-5		110		110		70		60
6-7	LOW	90	LOW	90	LOW	60	LOW	50
8-9		70		70		50		30
10-12		50		50	MEDIUM	30		20
13-15		30	MEDIUM	40		20	MEDIUM	20
16-20	MEDIUM	20		30		0		0
21-25		20		20	HIGH	0		0
26-30		0	HIGH	20		0	HIGH	0
31-40	HIGH	0		20		0		0
41-50	VERY HIGH	0		20	VERY HIGH	0	VERY HIGH	0
51-60		0	VERY HIGH	0		0		0
61 +	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0	ESCESSIVE[3]	0

100 kg/ha = 90 lb/ac

[1] *For use only where seed is banded directly above the drilled fertilizer.*

[2] *Where manure is applied, reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils). Examples of fertilizer application: An established stand of hay containing over 50% alfalfa would require no nitrogen (see table 39). If it were not manured and the soil tests were 14 phosphorus and 110 for potassium, the phosphate requirement would be 20 kg/ha (from above table) and the potash requirement 70 kg/ha (Table 42). This could be supplied by broadcasting 45 kg/ha (20 ÷ 46 x 100) of 0-46-0 and 120 kg/ha (70 ÷ 60 x 100) of 0-0-60 prior to the fall rest period.*

[3] *Excessive readings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.*

Table 42. Potash Requirements for Forages Based on OMAF Soil Tests

	At Seeding with or without nurse crop		Fall applications for new seeding and established stands			
Ammonium Acetate Potassium Soil Test			Alfalfa[2]		Other Forages	
(ppm)	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha
0-15	LOW	90	LOW	480	LOW	250
16-30		80		400		220
31-45		70		320		190
46-60		50		250		160
61-80		40		200		120
81-100		30		120		90
101-120	MEDIUM	20		70	MEDIUM	70
121-150		20	MEDIUM	40		40
151-180	HIGH	0	HIGH	0	HIGH	0
181-250	VERY HIGH	0	VERY HIGH	0	VERY HIGH	0
251 +	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied, reduce the fertilizer according to the amount and quality of manure (see Manure Section in Soils).*

[2] *Stand of 50% Alfalfa or more. Stands of less than 50% Alfalfa should be fertilized the same as other forages.*

[3] *Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 251 occur occasionally on clay and clay loam soils, but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.*

Plant Analysis

For forage legumes sample each species separately. The plant cut at normal mowing height at the late bud stage is recommended. However plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results when the samples are not taken at the late bud stages.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis* section in *Soils*.

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Table 43. Interpretation of Plant Analysis for Alfalfa[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	—	5.5
Phosphorus (P)	%	0.20	0.5
Potassium (K)	%	1.7	3.5
Calcium (Ca)	%	—	4.0
Magnesium (Mg)	%	0.20	1.0
Sulphur (S)	%	0.22	—
Boron (B)	ppm (ug/g)	20	90
Copper (Cu)	ppm	5	30
Manganese (Mn)	ppm	20	100
Molybdenum (Mo)	ppm	0.5	5.0
Zinc (Zn)	ppm	10	70

[1] *Values apply to the plant cut at normal mowing height at the late bud stage.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Micronutrients

The micronutrient boron is particularly important for alfalfa. However, boron fertilizer applications are not required on all soils. Boron deficiency shows up mainly on high pH sandy soils. Boron applications are recommended on all sandy soils and in particular, the sandy loam and loam soils in the area east of the Niagara Escarpment to and including Frontenac County.

A shortage of available boron to the alfalfa plant first affects flowering and reduces seed-set. As the deficiency becomes more serious, the youngest upper leaves of the plant become yellow to red in color in different plants. Growth can be severely stunted and winter hardiness reduced.

Boron deficiency can usually be corrected or prevented by an application of 1.0 to 2.0 kg boron/hectare broadcast annually.

Mixtures of herbicides and fertilizers should not be applied to crop foliage unless recommended by competent authorities.

For further details on boron deficiency and on methods of application see OMAF Factsheet, *Boron Requirements of Alfalfa*, Agdex 121/531.

Manure

Manure is an excellent source of nutrients and can substitute for manufactured fertilizers. It is an excellent source of nitrogen for grasses but forage legumes do not make efficient use of manure nitrogen. Do not apply manure to perennial forage legumes when there is snow cover because ice frequently forms under the manure and can kill the plants (see *Manure* section in *Soils*).

Liming

Legumes generally are not tolerant of acid soil conditions. Acid soils should be limed one year before seeding, at rates indicated by soil tests.

DISEASE AND INSECT CONTROL IN FORAGE CROPS

(see also Pesticides section)

DISEASES

Verticillium Wilt of alfalfa now occurs in many areas of southern Ontario. Wilt is easily spread from field to field by machinery, on hay, or in manure. For identification of wilt, contact your local crops specialist. Consult Tables 21 and 22 for information on variety resistance to verticillium wilt. See OMAF Factsheet, *Verticillium Wilt of Alfalfa*, Agdex 121/600.

Leafspot diseases, Anthracnose of alfalfa: **Northern Anthracnose** of red clover. Timely harvesting of forage is important to reduce leaf loss and minimize disease in the regrowth. Clean harvest equipment of crop debris before using the equipment in the spring or when moving from field to field.

Phytophthora root rot is a soil-borne disease which can result in root injury or death of alfalfa plants. Young plants in new seedings are particularly prone to damage. The disease shows up in Ontario mainly on poorly drained soils or on clay loam soils during extended periods of wet weather. Consult Tables 21 and 22 for information on variety resistance to phytophthora root rot.

Other crown and root rots of alfalfa and red clover. Stresses such as leaf diseases, insects, frequent or untimely harvests, winter conditions and low soil pH increase severity of crown and root rots. Stresses during the growing season render the plants more susceptible to winter stress. Good crop management practices, especially a good harvesting schedule, and maintenance of adequate soil fertility and proper pH help to reduce disease severity. Control leafhoppers in alfalfa. Avoid mechanical injury of the crowns as much as possible. Crowns are easily injured by machinery and by livestock tramping, especially when the soil is wet.

INSECTS

Alfalfa Weevil Fungal disease and several species of parasites which help control the weevil are now established throughout Ontario and in most years forage stands do not warrant treatment with insecticides. However sporadic outbreaks still occur and farmers should check their fields carefully each year to detect threatening infestations. For more information on the alfalfa weevil, see OMAF Factsheet, *Alfalfa Weevil* Agdex 121/622. For early detection of damaging populations, see OMAF Factsheet, *Early Warning System for Alfalfa Weevil Management*, Agdex 121/622.

The larvae cause most of the damage. They hatch from eggs deposited in the stems and crawl to the tops of alfalfa where they feed on the developing leaf and flower buds. In heavy infestations, they shred the leaves so badly that fields take on a grayish-white or frosted appearance. Experience in Ontario has shown that the peak of larval attack coincides with the bud stage of the first crop. When threatening infestations occur, fields should be cut immediately to eliminate feeding damage. The bud stage is also the best time to cut the crop for maximum yield of protein.

The key to weevil control is proper timing of harvest and treatment based on field inspection. Examine each field twice a week from mid May to June. Check several areas throughout the field. Look for damage to show up first on shallow soils or on southerly slopes.

1. **First Cut** If 25% of the stems have feeding damage in the tips, cut and remove from fields as soon as possible. If it is not possible to cut the crop immediately, treat with an insecticide as recommended in the following table.
2. **Second Cut** If damage was serious on first cut, feeding may continue and early regrowth should be carefully checked. If feeding retards regrowth, apply an insecticide.

Table 44. Alfalfa Weevil Control

Insecticide	Product per ha	Days to Cutting or Grazing
Furadan 480F*	285mL	7
Imidan 50 WP	2.2 kg	7
Malathion 500 EC[1]	2-2.75L	7
Methoxychlor 240EC	5.5L	7
50 WP	2.2 kg	

**Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*
EC (Emulsifiable Concentrate); F (Flowable);
WP (Wettable Powder).

[1] *Less effective below 16°C*

CAUTION: See the warning PROTECT HONEYBEES in *Disease & Insect Control* in the Corn section. When planning to apply a pesticide, advise local beekeepers so that they have an opportunity to move colonies out of the danger area. Your local agricultural representative has a listing of the beekeepers in your area. Remember that bees are invaluable as pollinators for seed production and are commonly attracted in large numbers to flowering forage legumes.

Alfalfa Blotch Leafminer This pest of alfalfa is now present throughout Ontario. The adult leafminer is a small fly which emerges in late May. It is best identified by the numerous pinhole punctures it makes in alfalfa leaflets when it feeds and lays eggs. After the eggs hatch, the developing maggots feed inside the leaflet eating away the center part and producing mines or tunnels that terminate in blotches.

A species of parasite that helps control the alfalfa blotch leafminer is now established across Ontario. Insecticides are generally not required and are not effective unless applied in the "pinhole" stage. If severe pinholing occurs and the crop can not be harvested early, Imidan, or Methoxychlor as listed in table 44 may be used.

For early detection of damaging infestations, see Canadex Leaflet, *Early Warning System for Alfalfa Blotch Leafminer Management in Ontario*, Agdex 121/622.

Potato Leafhopper The potato leafhopper causes a substantial loss in alfalfa yield and quality some years, particularly during dry seasons when plants are under stress. Damage to direct seedings may be severe. The first cut of established fields escapes injury but as leafhoppers become more prevalent in late June to mid August, damage may be severe.

The potato leafhopper is a light green, wedge-shaped insect about 0.3 cm long when fully grown. The immature or nymph stage is yellowish-green and wingless but otherwise resembles the adult. Adult leafhoppers may jump or fly. Nymphs walk sideways or backwards to hide on the underside of the leaves.

This insect feeds by sucking plant juices. The alfalfa is stunted and the leaves turn yellow to bronze in color. A discolored V-shaped or triangular area often develops on the tips of leaflets. While this marking is characteristic of leafhopper presence, the leaf discoloration may also be a disease symptom or nutritional defidiency.

Effective control of the potato leafhopper depends on recognizing the adults and nymphs before symptoms become apparent. Check alfalfa fields frequently beginning in late June. See OMAF Factsheet, *Potato Leafhopper in Alfalfa*, Agdex 121/622. When leafhoppers are found, spray with one of the following.

Table 45. Leafhopper Control

Insecticide	Product per ha	Days to harvest
Cygon 480 E	425 mL	2
Methoxychlor 240 EC	5.5 L	7
50 WP	2.2 kg	7

E or EC (Emulsifiable Concentrate);
WP (Wettable Powder).

Alfalfa Snout Beetle. This potentially serious pest of forage crops has recently been discovered in eastern Ontario near Prescott. The adult is a flightless dark grey weevil, about 12 mm long. It emerges in early spring, feeds on alfalfa shoots and migrates into new fields to lay eggs. All the adults are female. The eggs hatch into white legless grubs which feed on the main and side roots of the host plant. The grubs girdle the tap root or gouge its surface leaving deep spiral grooves. The total life cycle requires a span of two years. Damage is most evident in late summer and early fall. Wilted plants should be dug and checked for damage and the presence of grubs. Alfalfa is the preferred host but the grubs also attack clover and a number of weeds. Infested alfafa fields should be plowed under and planted to corn, soybeans or cereals for three years to reduce populations.

Until recently, the distribution was limited to northern New York State and a number of the St. Lawrence River Islands. If you suspect that you have this pest, consult your local OMAF office or Agriculture Canada's Plant Research Centre at Ottawa.

Armyworm Maintain a close watch for outbreaks in grasses in late June and July. If they become destructive, control them as indicated in **Disease and Insect Control** in Cereal Crops section.

Cereal Leaf Beetle Refer to quarantine regulations under Insects, Cereal Crops section, concerning movement of hay.

European Skipper This is an occasional but important pest of timothy, both in hay and seed production. The adult is an orange butterfly with a 2.5 cm wing spread. It congregates in damp places and skips about hay fields in mid summer. The larvae are light green caterpillars up to 2.5 cm long, usually found within rolled leaves where they feed. Leaf margins become irregularly notched and when abundant they defoliate timothy. Fields must be checked for the caterpillars by late April or early May. Initially, the small caterpillars have black heads but soon become a brown color with two light bands. If six caterpillars in an area 30 cm x 30 cm are found as early as the brown-headed stage, treat the field or the infested area. Use either Thuricide HPC at 2.25 L/ha or Dipel at 0.3-0.6 kg/ha. Note that these insecticides will not immediately kill the caterpillars. However, they will stop feeding.

Grasshoppers If grasshoppers become destructive, control them by spraying with an insecticide listed in Table 71 in the *Field Peas & Field Beans* Section, or with + Guthion 240SC at 1.4 L/ha.

+ Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.

WEED CONTROL IN FORAGES

For weed control recommendations see OMAF Publication 75, *Guide to Chemical Weed Control*.

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CEREAL CROPS

CROP MANAGEMENT

Grain crops deserve to be treated as first-rate crops whenever they are included in a cropping program. They must compete for their place in that program by producing high yields economically. To produce high yields requires that all parts of the grain production package be considered. No one factor can support high yields without the others. No one factor can be neglected without a corresponding decrease in yields.

Improved varieties express their full potential only when they are used in combination with proper seeding times, seeding depth, and recommended seeding rates as well as adequate fertility applications. Indeed they perform well only when diseases, insects, and weeds are eliminated as production hazards.

Integrating the production practices into a package becomes the problem of the farmer. On his ability to do this rests the final yield and outcome of his grain production program.

Planting date

Spring Grains

All spring grains respond with higher yields to early seeding. Because cool moist conditions in the spring promote ample tillering and large heads, plant as early as soil conditions permit. The target date should be April 10 for southwestern Ontrio, April 15 for central and eastern Ontario and May 10 for Northern Ontario. Planting delays much beyond the target date generally result in a significant yield reduction. **Mingo**, **Bruce** and **Leger** barley and **Donald**, **Ogle** and **Oxford** oats do not show as great a yield reduction with late planting as do other spring cereal varieties. These varieties should be considered for circumstances where late planning cannot be avoided.

Winter Grains

For good winter survival, seed early enough to obtain adequate top growth and root development in the autumn. For winter wheat grown in areas II and III this is between September 15 - 30 and two weeks later in area I. For winter barley seeding rates should be 1 - 2 weeks earlier than winter wheat.

Seeding rate

Seeding rate recommendations are given in Table 46 and on page 71. The higher range of rates should be used (a) where emergence and early seed establishment is likely to be poor eg. poor seed bed and aerial or broadcast seedings and (b) for late planting where tillering will be reduced.

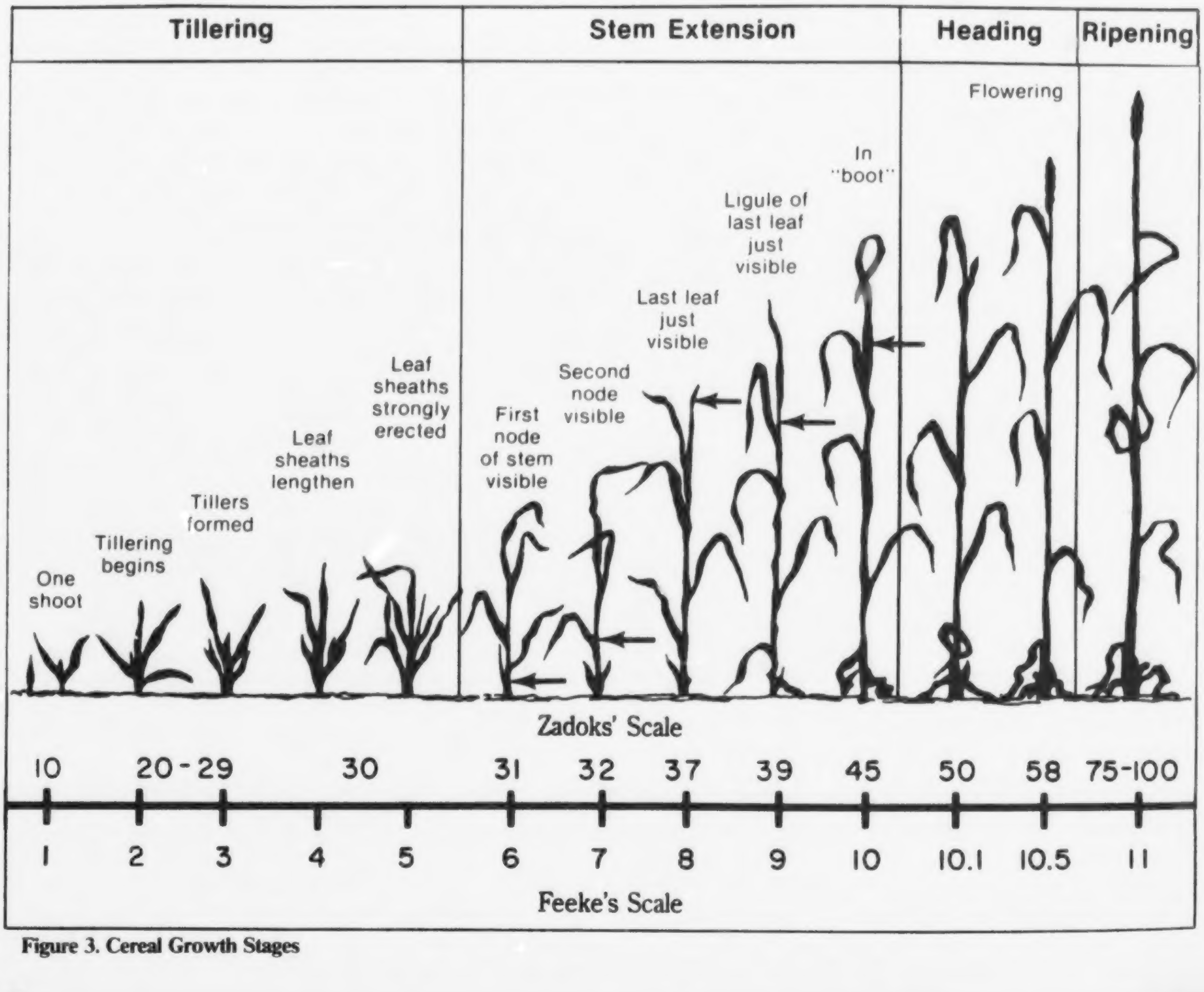
Tillering
Stem Extension
Heading
Ripening
Flowering
One shoot
Tillering begins
Tillers formed
Leaf sheaths lengthen
Leaf sheaths strongly erected
First node of stem visible
Second node visible
Last leaf just visible
Ligule of last leaf just visible
In "boot"
Zadoks' Scale
10
20-29
30
31
32
37
39
45
50
58
75-100
1
2
3
4
5
6
7
8
9
10
10.1
10.5
11
Feeke's Scale

Figure 3. Cereal Growth Stages

Seeding rate can be determined using the following formula:

$$\text{Seeding Rate (kg/ha)} = \frac{\text{plants/m}^2}{\text{\% germination}} \times \text{TKW}$$

For instance if you want 200 plants/m² of Leger barley with a germination of 90% the seeding rate is 87 kg/ha (200 ÷ 90 x 39).

The thousand kernel weights (TKW) given in the tables are averages and may vary depending on the lot.

Table 46. Seeding Rates

	Seeding Rate	
Crop	**Plants/m²**	**Plants[1]/ metre of row**
Barley	200-400	35-70
Oats	165-330	30-60
Wheat	240-320	45-60

[1] *For drills with 18 cm (7 inch) spacing.*

Lodging Control

For fields where lodging is expected a plant growth regulator such as Cerone or Cycocel Extra may be used.

At present Cerone is registered for use on all spring Barley varieties except Birka, Micmac and Rodeo and all winter wheat varieties. It should be applied at Zadoks' growth stages 37-45 (See Figure 3).

Cycocel Extra is registered on the hard red wheat variety Monopol. It is applied at Zadoks' growth stages 23-31 (See Figure 3).

For information on rates and application procedure, consult the product labels.

VARIETY SELECTION

Variety recommendations are general guides for choosing a variety. Descriptive tables accompanying recommendations show characteristics for each variety which may limit its use. Because no variety is perfect, the recommendations should be coupled with experience and information from the description to choose a variety for your use.

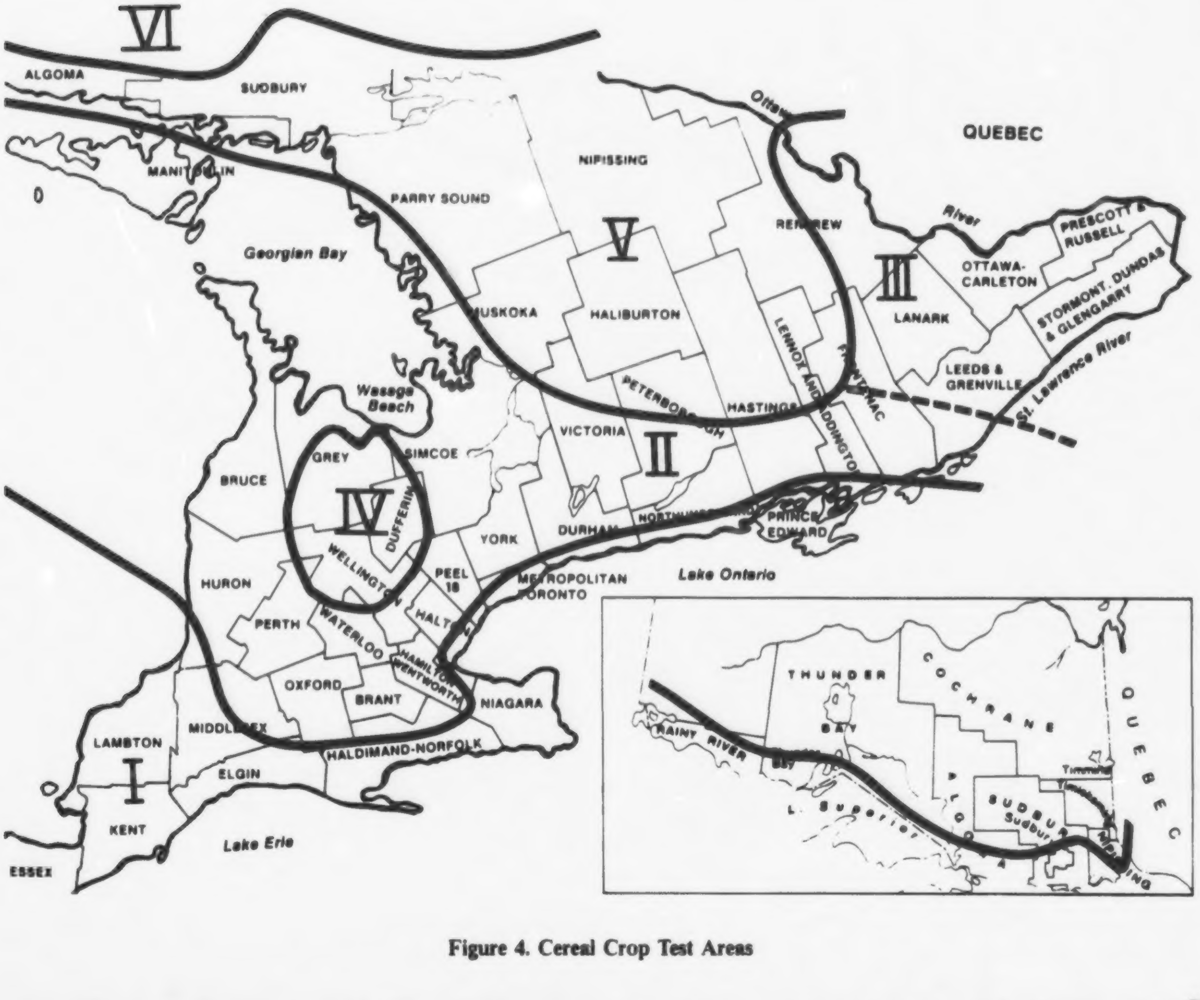
VI
ALGOMA
SUDBURY
MANITOULIN
PARRY SOUND
NIPISSING
Ottawa River
QUEBEC
RENFREW
V
III
Georgian Bay
PRESCOTT & RUSSELL
OTTAWA-CARLETON
STORMONT, DUNDAS & GLENGARRY
LANARK
MUSKOKA
HALIBURTON
LENNOX AND ADDINGTON
FRONTENAC
LEEDS & GRENVILLE
St. Lawrence River
Wasaga Beach
PETERBOROUGH
HASTINGS
VICTORIA
II
GREY
SIMCOE
BRUCE
IV
DUFFERIN
NORTHUMBERLAND
PRINCE EDWARD
DURHAM
YORK
WELLINGTON
HURON
PEEL 18
METROPOLITAN TORONTO
Lake Ontario
PERTH
HALTON
WATERLOO
HAMILTON-WENTWORTH
OXFORD
BRANT
NIAGARA
LAMBTON
MIDDLESEX
HALDIMAND-NORFOLK
I
ELGIN
KENT
Lake Erie
ESSEX
THUNDER BAY
COCHRANE
QUEBEC
RAINY RIVER
L. Superior
ALGOMA
SUDBURY
Sudbury
NIPISSING

Figure 4. Cereal Crop Test Areas

Yield data, presented as tonnes per hectare (t/ha), are included to indicate the relative yield performance of recommended varieties in each of the six testing areas in Ontario. (See Figure 4).

Variety recommendations for grains to be stored and used as high moisture grains and whole plant silages are the same as those to be used for normal grain storage and use.

SPRING GRAINS

Milling Oats

Milling oats have to meet special quality requirements: plump kernels, high hectoliter weight and groats that are free of discoloration. **Donald, OAC Woodstock** and **Ogle** are preferred for milling purposes.

Hulless Oats

Because they lose their hulls during threshing, hulless oats yield 1/4 - 1/3 less than regular oats. They are high in energy, and protein can range from 14-20% depending on fertility conditions.

Tibor can be grown like regular oats but special attention must be paid to combining, handling and storage.

For further information, contact your local OMAF office.

Mixed Grains

Mixed grains occupy a large hectareage in the province. No specific recommendations regarding the best mixtures can be made. Generally the highest yielding varieties of oats and barley in pure stands also perform best in mixtures.

Height and maturity ratings of the components of a mixture must be matched. For example, Donald oats match well with Leger or Rodeo barley, and Ogle oats match well with Birka or Leger barley.

An advantage of mixed grains is that leaf and head diseases usually are much less severe than where oats or barley are grown alone.

Spring Wheat

Feed Wheat

In areas III, IV, V and VI some varieties can be competitive with oats and barley as feed grain. For those farmers who choose to grow spring wheat for feed the following varieties are available.

Glenlea — awnless, white chaff and large red grain. Utility type wheat not equal in quality to hard red spring types.

Laval 19 — awned, white chaff and medium size purple grain. Feed type with no milling quality.

Milling Wheat

To ensure a market, care must be taken to grow a quality product. This includes such factors as early planting and control of weeds which may be a problem in Western Canadian varieties, with their more open canopy as compared to barley.

Columbus — A Western Canadian hard red wheat. It has a medium to good straw, is susceptible to mildew and moderately resistant to leaf rust. It has good to excellent sprouting resistance.

Katepwa — A Western Canadian hard red wheat. It has a medium straw, and is susceptible to mildew and moderately resistant to leaf rust. It is somewhat earlier than Columbus.

Max — A German variety which is grown under an intensively managed system. Under conventional management it shows medium straw strength, resistance to mildew and succeptibility to leaf rust.

Table 47. Recommended Barley Varieties

							Diseases[5]				
Variety	Area Recommended	Type	Seed Size[1] (g/1000 seeds)	Height[2] (cm)	Lodging[3]	Maturity[4]	Leaf Rust	Loose Smut	Scald	Spot Blotch	Mildew
2-Rowed											
Birka	All	Rough-awned	43	77	2	100	3	3	5	8	1
Rodeo	All	Rough-awned	43	79	2	99	5	3	8	8	1
Micmac	All	Rough-awned	42	81	3	98	5	8	8	8	1
6-Rowed											
Bruce	V,VI	Rough-awned	39	82	3	96	8	5	5	2	8
Leger	All	Smooth-awned	39	94	3	97	8	1	5	8	7
Mingo	All except VI	Smooth-awned	39	93	4	98	8	5	5	8	8
Sophie	All except V,VI	Smooth-awned	39	92	4	100	8	5	5	8	8

Values are given to indicate relative differences between varieties; actual values will differ depending on growing conditions and disease pressures.

[1] *Thousand Kernel Weight (TKW)*

[2] *In general plants will be taller in the south and shorter in the north*

[3] *Scale of 1-9 where 1 = standing and 9 = flat*

[4] *Days to harvest. Subtract 5 days for areas I-IV and add 10 days for area VI*

[5] *See Disease and Insect Control in Cereal Crops. Scale of 0-9 where 0 = very resistant and 9 = very susceptible*

Spring Triticale

Spring triticale is not generally grown in Ontario as it is later maturing than the other spring cereals. For those farmers who choose to grow spring triticale for feed, the variety **OAC Triwell** is available. It is a rough-awned, white-chaffed variety with good standability and good resistance to powdery mildew and leaf rust. If stands are thin or the crop is stressed around flowering, ergot contamination of the grain can be a problem.

Table 48. Barley Variety Yields[1,2], Tonne/Hectare

	Test Area					
Variety	**I (14)[3]**	**II (48)**	**III (10)**	**IV (13)**	**V (10)**	**VI (11)**
Birka	3.5	3.7	4.3	3.8	3.5	4.2
Rodeo	3.6	3.7	4.2	3.7	3.7	4.3
Micmac	3.7	3.7	4.8	4.4	3.4	4.3
Bruce	3.3	3.5	3.6	3.4	3.6	4.3
Leger	3.7	3.9	4.4	3.9	3.9	4.7
Mingo	3.4	3.7	4.2	3.6	3.7	3.8
Sophie	3.5	3.5	4.4	3.4	3.5	4.4

[1] *1 t/ha = 893 lb/ac*

[2] *Five year average (1982-1986) except for Micmac which is a two year average (1985-86)*

[3] *Number of tests*

Table 49. Oat Variety Yields[1,2], Tonne/Hectare

	Test Area					
Variety	**I (14)[3]**	**II (48)**	**III (10)**	**IV (13)**	**V (10)**	**VI (11)**
Donald	3.1	3.7	4.0	4.1	3.3	3.5
Dumont	3.1	3.6	4.4	3.9	3.4	3.7
Marion	3.2	4.0	4.7	4.5	3.5	3.9
OAC Woodstock	3.0	3.7	4.5	3.9	3.2	3.6
Ogle	3.6	3.9	3.9	4.1	3.7	3.1
Oxford	3.2	3.7	4.2	3.6	3.5	3.5

[1] *1 t/ha = 893 lb/ac*

[2] *Four year average (1983-1986) except for Marion which is a two year average (1985-86)*

[3] *Number of tests*

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Table 50. Recommended Oat Varieties

							Diseases[5]			
Variety	**Area Recommended**	**Type**	**Seed Size[1] (g/1000 seeds)**	**Height[2] (cm)**	**Lodging[3]**	**Maturity[4]**	**Leaf Rust**	**Barley Yellow Dwarf**	**Septoria**	**Smut**
Donald	All	white	36	101	3	103	8	5	8	1
Dumont	III,V,VI	white	33	100	4	106	1	8	8	1
Marion	All	white	37	111	3	103	8	8	8	5
OAC Woodstock	All	white	33	107	3	105	8	8	5	1
Ogle	All	yellow	32	90	2	101	5	3	3	5
Oxford	All	yellow	31	104	2	105	5	5	3	1

Values are given to indicate relative differences between varieties; actual values will differ depending on growing conditions and disease pressures.

[1] *Thousand Kernel Weight (TKW)*

[2] *In general plants will be taller in the south and shorter in the north*

[3] *Scale of 1-9 where 1 = standing and 9 = flat*

[4] *Days to harvest. Subtract 5 days for areas I-IV and add 10 days for area VI*

[5] *See Disease and Insect Control in Cereal Crops. Scale of 0-9 where 0 = very resistant and 9 = very susceptible*

WINTER GRAINS

Winter Wheat

Soft White Winter Wheat. Soft white winter wheat has long been the dominant winter grain of Ontario. Markets are well established, and varieties well adapted to Ontario conditions are available (Table 51). It should be the first choice for farmers wishing to grow a cash crop winter cereal.

Hard Red Winter Wheat. Hard red winter wheat is now grown in Ontario. Available varieties (predominantly **Monopol**) are being widely tested for quality and adaptability to local conditions. The quality of the hard red winter wheat is very different from that of the traditional soft white varieties. Because of this, the two types should be kept separate throughout the production and marketing channels. Mixed lots will only find a use as livestock feed, and will thus realise a lower price than unmixed lots of wheat of milling grade.

Monopol is a German variety grown under an intensively managed system. Under conventional management it shows good straw strength and susceptibility to mildew.

Table 51. Recommended Soft White Winter Wheat Varieties

Variety	Area Recommended	Seed Size[1] (g/1000 seeds)	Height (cm)	Sprouting	Lodging[2]	Diseases: Leaf Rust[3]	Diseases: Scab[4]	Diseases: Mildew[3]
Augusta	I, II, III	35	101	Medium	2	3	23	4
Frankenmuth	I[5], II[5]	33	100	Medium	3	5	11	4
Fredrick	I[5]	34	105	Medium to good	3	4	6	4
Gordon	III[6]	33	99	Medium to poor	4	6	8	5
Harus	I, II	35	96	Medium to good	2	4	8	3
Houser	I[6], II[6], III[6]	35	95	Poor	4	5	5	3

Winter survival is similar for all varieties.

All varieties should be seed treated to control loose smut. For further information see OMAF Factsheet, Winter Wheat in Ontario, Agdex 120/10.

Values are given to indicate relative differences between varieties; actual values will differ depending on growing conditions and disease pressures.

1. *Thousand kernel weight (TKW)*
2. *Scale of 1-9 where 1 = standing and 9 = flat*
3. *Scale of 0-9 where 0 = very resistant 9 = very susceptible*
4. *Number of plants infected per 1000.*
5. *Only where test weight is a problem with other varieties*
6. *Not on light droughty soils and other locations where test weight is a problem.*

Table 52. Soft White Winter Wheat Variety Yields and Test Weights[1]

Variety	Yield[2] (tonne/ha) Test Areas I (24)[4]	II (24)	III (11)	Test Weight[3] (kg/hL) Test Areas I (22)	II (24)	III (9)
Augusta	4.4	5.0	5.5	74	73	78
Frankenmuth	4.2	4.7	5.1	76	75	79
Fredrick	4.0	4.7	4.8	77	76	81
Gordon	4.0	4.5	5.3	72	71	79
Harus	4.4	5.1	5.0	75	75	79
Houser	4.2	4.8	5.4	72	71	77

[1] *Five year average (1982-86)*
[2] *1 t/ha = 893 lb/ac*
[3] *kg/hL x .801 = lb/bu*
[4] *Number of tests*

Winter Barley Winter barley has higher yield than spring barley but is considerably less winterhardy than winter wheat. It can be expected to survive only in areas I and II with adequate snow cover. Winter barley matures much earlier than winter wheat and if harvested as a silage crop is suitable for double cropping.

OAC Halton is a six-rowed, rough-awned cultivar with short straw and good lodging resistance. It is resistant to leaf rust and mildew but susceptible to scald in most areas.

OAC Acton is a six-rowed, rough-awned cultivar with rust and lodging resistance similar to OAC Halton. It has longer straw, higher yield, better scald resistance and barley yellow dwarf tolerance than OAC Halton but is susceptible to current races of mildew.

Winter Triticale Two feed-type varieties are now licensed: **OAC Wintri** and **OAC Decade**. OAC Wintri has better winter survival compared to the recommended winter wheat varieties. It is very tall, later maturing than Fredrick, and has poor lodging resistance, especially on heavier soils. High levels of nitrogen fertilization can result in lodging problems with yield losses. OAC Decade is much shorter than OAC Wintri and has improved lodging resistance.

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Table 53. Distributors for Cereal G[illegible] Varieties

	Variety	Distributor[1]	Breeder
Barley	Birka	W.G. Thompson & Sons Ltd.	Weibull's, Sweden
	Bruce	SeCan Members	OAC Guelph
	Leger	SeCan Members	Ottawa Res. Station
	Micmac	SeCan Members	Charlottetown Res. Station
	Mingo	W.G. Thompson & Sons Ltd.	Ciba-Geigy, Ailsa Craig
	Rodeo	W.G. Thompson & Sons Ltd.	Ciba-Geigy, Ailsa Craig
	Sophie	Jean Labonte et Fils Inc.	U. Laval, Ste. Foy Res. Station
Oats	Donald	SeCan Members	Ottawa Res. Station
	Dumont	SeCan Members	Winnipeg Res. Station
	OAC Woodstock	SeCan Members	OAC Guelph
	Ogle	public	U. of Illinois
	Oxford	W.G. Thompson & Sons Ltd.	OAC Guelph
Spring Triticale	OAC Triwell	Speare Seeds Ltd.	OAC Guelph
Spring Wheat			
Feed	Glenlea	public	Univ. of Manitoba
	Laval 19	King Agro Inc.	Univ. of Laval
Milling	Columbus	SeCan Members	Winnipeg Res. Station
	Katepwa	SeCan Members	Winnipeg Res. Station
	Max	C&M Seeds, Aishling Farm Seeds	Dr. Hegge, Germany
Winter Barley	OAC Acton	King Agro Inc.	OAC Guelph
	OAC Halton	SeCan Members	OAC Guelph
Winter Triticale	OAC Decade	King Agro Inc.	OAC Guelph
	OAC Wintri	King Agro Inc.	OAC Guelph
Winter Wheat Soft White	Augusta	W.G. Thompson & Sons Ltd.	Michigan State Univ.
	Frankenmuth	King Agro Inc.	Michigan State Univ.
	Fredrick	public	Ottawa Res. Station
	Gordon	SeCan Members	Ottawa Res. Station
	Harus	SeCan Members	Harrow Res. Station
	Houser	W.G. Thompson & Sons Ltd.	Cornell Univ.
Hard Red	Monopol	C&M Seeds, Aishling Farm Seeds	Baywa, Germany

[1] *See Distributor Addresses in General Section.*

FERTILIZERS FOR CEREAL CROPS

Nitrogen

Nitrogen fertilizer recommendations for cereal crops are given in tables 54 and 55. High rates of nitrogen from manures or manufactured fertilizers can cause lodging of cereals.

Table 54. Nitrogen Requirements - Cereal Crops

Crops	N required[1] kg/ha
Barley (areas receiving 2600 heat units or less)	70
Barley (areas receiving more than 2600 heat units)	45
Oats, buckwheat, millet, spring rye (southern Ontario)	35
Oats, buckwheat, millet, spring rye (northern Ontario)[2]	55
Mixed grain, spring wheat and triticale, flax, fodder rape, kale, sunflower (southern Ontario)	45
Mixed grain, spring wheat and triticale, flax, fodder rape, kale, sunflower (northern Ontario)[2]	70
Cereals seeded as a nurse crop for forages	15
Winter Triticale	80[3],[4]
Winter barley, winter rye	90[3],[4]

100 kg/ha = 90 lb/ac

[1] *Where manure is applied or the preceding crop is a legume sod, reduce the nitrogen rates as shown in Tables 4 and 5.*

[2] *Northern Ontario refers to Algoma, Cochrane, Kenora, Manitoulin, Nipissing, Rainy River, Sudbury, Temiskaming and Thunder Bay districts.*

[3] *0 to 10 kg nitrogen per hectare at seeding and 90 to 80 kg nitrogen per hectare in early spring.*

[4] *When not in rotation with tobacco.*

Table 55. Nitrogen Requirements for Soft White Winter Wheat[1]

Cost of Nitrogen Fertilizer	Expected Yield[2] - t/ha 3.5	4.5	5.5
$/kg	Most Profitable Nitrogen Application[4],[5] - kg/ha		
.50	80	90	110
.60	75	85[3]	110
.70	70	85	105

100 kg/ha = 90 lb./ac

[1] *Nitrogen requirements are based on winter wheat valued at $142/tonne.*

[2] *Expected yield is that yield which you, in your experience, should obtain under your conditions of soil, climate and management.*

[3] *If your expected yield is 4.5 t/ha and nitrogen costs $.60/kg, then 85 kg/ha of nitrogen is the most profitable rate of application.*

[4] *0 to 10 kg/ha of nitrogen at seeding, and the remainder in early spring.*

[5] *When not in rotation with tobacco.*

Phosphate and Potash

Phosphate and potash requirements for cereals are given in Tables 56 and 57. For information on use of these tables see *Soil Testing Section in Soils.*

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Table 56. Phosphate Requirements for Cereals Based on OMAF Soil Tests

	Spring barley and mixed grain		Oats, spring wheat, spring triticale, spring rye, fodder rape, canola, kale, flax, and buckwheat		Winter wheat, W. rye, W. barley, W. triticale		Winter or spring grains seeded down	
Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha
0-3		110		70		70		130
4-5		100		60		60		110
6-7	LOW	90	LOW	50	LOW	50	LOW	90
8-9		70		30		30		70
10-12		50		20		20		50
13-15	MEDIUM	20	MEDIUM	20	MEDIUM	20	MEDIUM	30
16-20		20		0		20		20
21-25		0	HIGH	0		0		20
26-30	HIGH	0		0	HIGH	0		0
31-40		0		0		0	HIGH	0
41-50	VERY HIGH	0	VERY HIGH	0		0		0
51-60		0		0	VERY HIGH	0	VERY HIGH	0
61 +	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quantity of manure (see Manure Section in Soils). For spring barley in an area with less than 2600 heat units, not manured and not following a legume sod, the nitrogen requirement is 70 kg/ha (see Table 54). If the soil tests are 11 for phosphorus and 48 for potassium the phosphate requirement would be 50 kg/ha and the potash requirement 50 kg/ha. These nutrients could be supplied by drilling 250 kg (50 ÷ 20 x 100) of 5-20-20 per hectare to supply the phosphate and potash and broadcasting 170 kg of 34-0-0 or 130 kg of 45-0-0 per hectare to supply the recommended amount of nitrogen.*

[2] *Excessive readings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.*

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

Table 57. Potash Requirements for Cereals Based on OMAF Soil Tests

	Spring barley and mixed grain		Oats, spring wheat, spring triticale, spring rye, fodder rape, kale, flax, buckwheat		Winter wheat, W. rye, W. barley, W. triticale with or without seeding down		Spring cereals seeded down	
Ammonium Acetate Potassium Soil Test (ppm)	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha
0- 15		90		70		50		90
16- 30		80		50		40		80
31- 45	LOW	70	LOW	40	LOW	30	LOW	70
46- 60		50		30		20		50
61- 80		40	MEDIUM	20		20		40
81-100		30		20	MEDIUM	20		30
101-120	MEDIUM	20	HIGH	0	HIGH	0	MEDIUM	20
121-150		20		0		0		20
151-180	HIGH	0		0		0	HIGH	0
181-210		0	VERY HIGH	0	VERY HIGH	0		0
211-250	VERY HIGH	0		0		0	VERY HIGH	0
251 +	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0	ESCESSIVE[2]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quantity of manure (see Manure Section in Soils).*

[2] *Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 250 occur occasionally on clay and clay loam soils but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.*

Plant Analysis

For cereals, sampling the top two leaves at heading is recommended. However plants suspected of nutrient deficiency should be sampled as soon as the problem appears. For plants less than 20 cm tall, sample the total above ground plant. Expert help will be required to interpret plant analysis results when the samples are not taken at heading.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis* section in *Soils*.

Table 58. Interpretation of Plant Analysis for Cereal Crops[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	2.0	2.7
Phosphorus (P)	%	0.1	0.5
Potassium (K)	%	1.0	3.0
Calcium (Ca)	%	—	1.0
Magnesium (Mg)	%	0.15	1.0
Boron (B)	ppm (ug/g)	3	40
Copper (Cu)	ppm	3	50
Manganese (Mn)	ppm	15	200
Zinc (Zn)	ppm	10	70

[1] *Values apply to the top two leaves sampled at heading.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Micronutrients

Manganese deficiency occurs occasionally on cereals in Ontario. Copper deficiency may occur on organic soils and is suspected in rare occasions on very sandy soils. Boron deficiency has not been diagnosed on cereals and boron applications can be toxic. Zinc deficiency on cereals does not appear to be a problem.

Manganese deficiency frequently occurs when wheat, oats or barley are grown on an organic soil. It can occasionally occur on mineral soils high in organic matter and on very sandy soils. On oats, manganese deficiency appears as irregular oval gray spots on the leaves. On barley and wheat, it appears more commonly as a light yellow color on the leaves with the veins in the leaf remaining slightly darker green. In addition to deficiency symptoms on leaves, both soil tests and plant analyses are useful in predicting where manganese deficiencies are likely to occur. Both are available at the OMAF soil testing and plant analysis laboratory. Correct the deficiency as soon as detected by spraying the foliage with 2 kg manganese/ha from manganese sulfate (8 kg manganese sulfate/ha) or 0.4 kg/ha of manganese in chelated form in 200 L of water.

A "spreader-sticker" in the spray is recommended for materials other than chelates. If the deficiency is severe a second spray may be beneficial.

Soil application is not a recommended way to apply manganese regardless of source because of the large amounts required. Manganese chelates should not be applied to the soil.

Mixtures of herbicides and foliar fertilizers should not be applied to crop foliage unless recommended by competent authorities.

For further details on manganese deficiencies and on methods of application, refer to OMAF Factsheet, *Manganese in Soybeans and Small Grain Production*, Agdex 100/531.

Methods of Application

Where phosphate fertilizer is required for cereal crops it is best drilled with the seed and may be accompanied by some or all of the required nitrogen and potash, depending on rates of application. For further information see table, *Maximum Safe Rates of Nutrients* in the *Soils Section*.

DISEASE AND INSECT CONTROL IN CEREAL CROPS

(see also Pesticides section)

Seed Treatment

Following cleaning, all cereal should be treated with a seed treatment. Good coverage of the seed is essential. Follow the precautions under *Seed Treatments in General Information on Pesticide Usage* section, when applying any chemical seed treatment.

Seed treatments control certain soil and seed-borne cereal diseases. The recommended seed treatments and diseases controlled are given in Table 59.

DISEASES

See OMAF Factsheets, *Leaf and Head Diseases of Barley, Agdex 114/632; Leaf Diseases of Winter Wheat*, Agdex 112/600; *Head Diseases of Winter Wheat*, Agdex 112/630; *Smut Diseases of Grain Crops*, Publication 524, *Root, crown and basal stem diseases of winter wheat*, Agdex 112/630.

Diseases Affecting Wheat, Barley and Oats.

Powdery mildew is favored by warm, humid weather. White powdery growth of the mildew fungus appears on the foliage and sometimes on the heads. Wheat, barley and oats are each attacked by different strains of the fungus. In areas prone to severe mildew, use the more resistant cultivars of winter wheat (Table 51) or resistant cultivars of barley (Table 47). Also see Table 60.

Table 59. Cereal Seed Treatments

		Diseases	**Oats** - covered smut	- loose smut	**Barley** - covered smut	- loose smut	- seedling blight	**Wheat** - common bunt	- dwarf bunt	- loose smut	- seedling blight	**Rye** - seedling blight
Product	**Active Ingredient**	**Formulation[2]**										
Agrox N-M	maneb	P-DB	+	+	+	—	—	+	—	—	+	+
Agrox flowable	maneb	S	+	+	+	—	—	+	—	—	+	+
Busan 30	TCMTB	EC	+	+	+	—	—	+	—	—	+	+
Co-op N M	maneb	P-DB	+	+	+	—	—	+	—	—	+	+
[1]Vitaflo-250	carbathiin	S	+	+	+	+	+[3]	+	—	+	—	—
[1]Vitaflo-280	carbathiin + thiram	S	+	+	+	+	+	+	—	+	+	+
[1]Vitavax Powder	carbathiin + thiram	P-DB	+	+	+	+	+	+	—	+	+	+
Seed treatments with Insecticides												
Mergamma N-M	maneb + lindane	P-DB	+	+	+	—	—	+	—	—	+	+
Co-op N M Dual Purpose	maneb + lindane	P-DB	+	+	+	—	—	+	—	—	+	+
[1]Vitaflo Dual Purpose	carbathiin + thiram + lindane	S	+	+	+	+	+	+	—	+	+	+
Vitavax Dual Powder	carbathiin + thiram + lindane	P-DB	+	+	+	+	+	+	—	+	+	+

[1] *Read the paragraph on seed treatments, and also the sections Loose Smut of Barley, Loose Smut of Wheat.*

[2] *EC (Emulsifiable Concentrate); P-DB (Powder Drill Box); S (Flowable Suspension).*

[3] *Reduces seedling blight caused by Spot Blotch, but may not control other seedling blights and seed decay.*

+*Recommended for disease listed.*

— *NOT recommended.*

Ergot occurs from time to time on barley and triticale. Exercise caution in feeding grain containing the black ergot bodies to livestock, especially swine. Do not sow seed containing ergot. Consult Agriculture Canada Publication 1438, *Ergot of Grains and Grasses*.

Barley Yellow Dwarf or Oat Red Leaf. This disease was unusually severe in 1959 and 1976. It is unlikely to be severe unless warm weather and southerly winds occur in April. Direct control by spraying the aphids which carry the virus is unlikely to be useful. Early seeding is an advantage in spring grains. Winter wheat also is susceptible to barley yellow dwarf. Late planting helps to avoid infection in the fall. See OMAF Factsheet, *Cereal Virus Diseases*, Agdex 110/632.

Wheat Diseases

Loose Smut. Sow pedigreed seed. Vitaflo -280 which contains cerbathiin for smut control and thiram for control of seedling blight is recommended for wheat grown for food or feed. All wheat grown for seed should be treated with Vitaflo -250 or the higher rate of Vitaflo -280 for effective smut control.

Dwarf bunt occurs primarily in counties bordering Georgian Bay and Lake Huron where snow cover is deep and persistant in late winter and early spring. The bunt fungus survives for many years in the soil and can also be seed-borne. It infects wheat in early spring. None of the registered seed treatments controls dwarf bunt effectively. Rotation of wheat with other crops aids control. Seed treated with the high rate of Vitaflo-280 may help prevent spread by means of seed.

Fusarium seedling blight can be carried on seed or in crop debris. The fungus causes poor germination and reduced plant stands. If the seed treatment already applied does not contain maneb or thiram, a seed treatment containing maneb or thiram should be added. See Table 59.

Fusarium Head Blight (Scab) outbreaks occur when the weather is warm and wet at the flowering to soft-dough stages. Vomitoxin may be present in diseased heads. See OMAF Factsheets, *Head Diseases of Winter Wheat*, Agdex 112/630 and *Moldy Feeds and Swine Diseases*, Agdex 440/660. Head blight is usually more severe when wheat follows wheat, corn or triticale. Plow down infested stubble and straw.

Eyespot, Strawbreaker and Take All are often damaging especially when wheat follows wheat. Avoid early planting. Clean plowing helps to reduce eyespot severity. Include crops such as soybeans, field beans, canola, clovers, alfalfa or oats in the rotation.

Septoria leaf spot is most severe at the heading stage but also develops under snow cover. Speckled brown spots develop on the leaves. A related disease develops on the heads as purplish-brown areas. Wet, windy weather and warm temperatures are favorable to disease development. Rotation with crops other than cereals and plowing down of cereal residues help to control leaf spot. See Table 60.

Leaf rust is often widespread, especially after wheat heads emerge. The rust fungus appears to overwinter on winter wheat and may also be blown from the U.S.A. Information on resistance of wheat varieties to leaf rust is given in Table 52. See also Table 60.

Stem rust may be serious in wheat grown near common barberry. The common barberry is the source of the rust fungus and should be destroyed. Contact your Area Weed Inspector or Ministry of Agriculture and Food office for assistance in identification and control. Consult OMAF Publication 49, *Rid Ontario of Common Barberry and European Buckthorn*. See Table 60.

Snow Mold. In years when snow mold causes great reduction in winter wheat stands, reseed as soon as possible with a spring grain. This disease does not affect spring-planted grain.

Barley Diseases

Loose Smut. Sow pedigreed seed of a resistant barley variety. However, these varieties are resistant ONLY to the prevalent races of smut fungus and may not resist other races. It is **strongly recommended** that **all barley seed be treated with Vitalfo -280** or a drillbox formulation containing carbathiin.

Table 60. Foliar Disease Control in Wheat*

		Diseases	Septoria Leaf Spot	Rust — Leaf	Rust — Stem	Powdery Mildew	Tan Spot
Fungicide	**Product/ha**	**Days to Harvest**					
**Bayleton 50W	250-550 g	60	—	+	+	+	—
Dithane M45	2.25 kg	40	+	+	—	—	+

W (Wettable Powder)

+ Recommended for disease listed

— NOT recommended

*Consult the fungicide label for the current registration status for the various varieties of wheat grown in Ontario and for the proper timing of application.

**Temporary Registration (Restricted). For more information see *Federal Registration and Provincial Classification*, inside front cover. Use only on hard red winter wheat. A Provincial Permit is required.

Spot Blotch, Seedling Blight, Root Rot and Head Blight are often serious and widespread and are caused by the same fungus. The fungus overwinters in seed, barley debris and soil. All barley seed should be treated with the fungicide Vitaflo-280 to control the fungus inside the seed and that which invades seedlings from the soil. To reduce severity of spot blotch and head blight, avoid growing barley after barley, wheat and grasses. Early planting helps to avoid serious disease in July. Disease is less severe on barley grown in mixtures with oats. Bruce barley shows some disease resistance.

Net Blotch and Scald occur especially in cool, humid seasons. Two-rowed barley usually are more susceptible to net blotch and scald than are 6-rowed barleys. To help prevent buildup of these diseases, avoid growing barley after barley, plow down stubble and straw as completely as possible, and treat seed with a fungicide containing carbathiin or maneb (Table 59).

Oat Diseases

Septoria Leaf Blotch in oats can cause severe damage in all recommended varieties. The disease is recognized by the appearance of mottled, light and dark brown, elongate blotches on the leaf blade, extending to the leaf sheath and culm. Advanced stages on the culm turn black and the weakened culm breaks over easily resulting in damage due to lodging. Avoid planting oats after oats or mixed grains.

Oat Leaf Rust is often serious, especially in central and eastern Ontario. European buckthorn is the source of the rust fungus. This shrub is described in O.M.A.F. Publication 49, *Rid Ontario of Common Barberry and European Buckthorn*. Information on resistance of oat varieties to leaf rust is given in Table 50.

Oat Cyst Nematode. Damage by the oat cyst nematode is first noticed about two or three weeks after oat plants emerge, at which time heavily infected plants appear to suddenly stop growing, leaves turn pale in color and begin to die back from the tips downward. These plants fail to tiller resulting in a thin stand of stunted plants which produce little grain. Below ground the root systems are severely stunted and usually discolored, from a pale-yellow in early growth to a yellow-brown in mature plants, as compared to the clear white in healthy plants.

To confirm suspected oat cyst nematode damage, dig up affected plants at early heading stage. Carefully wash soil from the roots by dunking in a pail of water, then examine the roots for presence of young cysts. These appear as tiny, pearl-like objects adhering to the young roots. If still in doubt, send a sample of several plants with adhering soil to the Pest Diagnostic Clinic, Department of Environmental Biology, University of Guelph, Ontario, N1G 2W1 for diagnosis.

If oat cyst nematodes have caused damage do not plant spring grains the following year. Use legume or row crops in the rotation. Corn can be used if the nematode population is low but will suffer damage if the soil is heavily infested. The nematode invades corn roots but does not reproduce in them; thus consecutive cropping to corn effectively reduced the population of oat cyst nematodes.

For additional information, see OMAF Factsheet, *Oat-Cyst Nematode*, Agdex 113/632.

INSECTS

Wireworms damage cereal crops in certain areas every year. Injury is usually most severe in the two years following grass sod. As a precautionary measure, use a drill-box formulation containing lindane (see Table 59). Use a wooden paddle to mix the chemical with the seed. Do not breathe the dust stirred up during mixing, wear rubber gloves and a respirator. Follow the precautions in Precautions with Pesticides section when using seed treatments.

Armyworms are brown to dark green caterpillars with five longitudinal stripes on their bodies. They are 4 cm long when fully grown. They appear in damaging numbers at intervals of about 10 years except for localized infestations which may appear at any time. The caterpillars appear in grain crops during late June to mid July depending upon geographical location. They can best be detected by examining crops frequently during early evening just before sunset; at this time the caterpillars are moving up on the plants to feed. They hide under clumps of grass and clods of dirt during the day. **Five to six larvae in an area 30 by 30 cm warrant chemical control.**

If foliage is heavily notched and most of the caterpillars are less than 4 cm long, treat immediately. When plants are completely defoliated and most caterpillars are fully grown, treatment is not practical. Each field must be assessed and dealt with separately. Armyworms often move in large numbers from one field to another. When this happens it is advisable to spray the border of the invaded field. There is no benefit in applying a control measure when the armyworm is nearly full grown, the pupae present, feeding extensive or the crop near "maturity". By this time most of the damage will have been done.

Malathion is less effective below 16°C. Where less than 60 L of spray are used per hectare, Lannate provides better control than the other insecticides.

Insecticides are listed in order of preference.

Table 61. Armyworm Control

Insecticide	Product/ha	Days to Harvest
Dylox 420 LC	1.5 L	21
*Lannate 215 L	2.0 L	20
Sevin SLR[2] 480 Su	5.0 L	20

[1] *LC (Liquid Concentrate); Su (Suspension); L (Liquid)*

[2] *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees. Follow precautions applying to honeybees. See Protect Honeybees section and the note below.*

**Minimum period before reentry is 24 hours.*

Bee Poisoning

During the past several years spraying for armyworms, especially with Sevin, has resulted in heavy bee kills. **This must be avoided.** Treat only when needed. Use an insecticide other than Sevin if bees are in the area. Avoid contamination of areas where weeds are in bloom. Do not spray when the wind is blowing. Treat in the late evening. If spraying by aircraft, avoid spraying close to roadsides and adjacent fields where plants are in bloom. Advise local beekeepers of your spraying activities. Your local agricultural representative has a list of beekeepers in your area.

Cereal Leaf Beetle is a metallic blue-green beetle 0.5 cm in length, with reddish-orange head and legs. The larva is slug-like in appearance, 0.6 cm in length when mature and yellowish in color, but its true color is obscured by a black deposit of fecal material. Eggs are pinhead in size, elongate and bright-yellow to dull brown in color located along the mid vein on the upper surface of the leaf.

Both the adults and larvae cause damage by chewing long strips of tissue between the leaf veins. However, most of this injury is done by the larvae in June. Heavily damaged fields take on a silvery appearance.

An effective parasite is now established throughout Ontario, which generally controls the cereal leaf beetle. However, treatments may be required in some fields when 2 larvae are found per stem.

Quarantine Regulations. A quarantine is in effect to prevent the spread of this insect to western Canada. Growers contemplating selling baled hay or straw to western Canada should contact the local office of the Food Production and Inspection Branch of Agriculture Canada.

Table 62. Cereal Leaf Beetle Control

Insecticide	Product/ha	Days to Harvest
Malathion 500 EC	.55 - 1.1 L	7
Sevin 80 S	1.5 kg	14

[1] *EC (Emulsifiable Concentrate); S (Sprayable)*

Grasshoppers. If they become destructive control them as indicated in the Field Bean section.

Aphids. Aphids are often found on cereals but are seldom numerous enough to cause reduced yields. There must be at least 75 aphids per head, the cereal not near maturity and no heavy rains forecast (which wash off some aphids) before spraying would pay. Immigrant aphids carry yellow dwarf virus. Unfortunately it is not possible to kill the aphids efficiently enough to prevent disease transmission to cereals.

INSECTS IN FARM STORED GRAIN

Insects are a major problem in farm stored grain in Ontario. Ontario producers sustain considerable losses annually. In some instances, shipments to elevators are refused because of insects.

The Key to Control of insects in stored grain is prevention through good sanitation and storage. The following are essential:

1. Clean up all spills of grain and feed. Such spilled material usually becomes infested and is a major source of insect problems. All residue grain that is removed should either be burned, deposited in a sanitary fill or ground up for feed.
2. Bins and equipment must be thoroughly cleaned before storing grain. This means cleaning out all caked material. Use a good vacuum cleaner. Such cleaning removes old grain that may be infested with insects that would spread to the new grain. In particular check:
   - corners and cracks
   - behind partitions
   - between double walls
   - outside and under bins
   - grain handling equipment
   - aeration piping
   - perforated floors

   There is a major problem with fully perforated floors. They cannot be lifted for cleaning and they get clogged and infested. This is an engineering problem and fumigation is costly and not always effective.
3. It is obvious that new grain must never be stored with old because any insects will spread from the old grain to the new.
4. After clean up, repair storage facilities so that they are pestproof.
5. Any remaining insects that would infest the grain can be killed by spraying the empty bins. Use 250-330 mL of malathion 500 EC in 5 L of water. This will treat 100 m^2 of bin surface. **Treat bins two weeks before grain storage.** Sprays are not a substitute for a thorough and complete clean-up. If bin surfaces are dusty or covered with caked material the spray will not penetrate or adhere to kill crawling insects.
6. Leave space between feed rooms and storage facilities because feed rooms are difficult to keep free of pests and insects can quickly spread to nearby storage facilities. For the same reason grain should not be stored in buildings that shelter animals or hay because mangers, feed boxes and troughs are often insect-infested. In addition, such buildings are warmer and thus insects can remain active throughout winter.
7. Molds, as well as insects are much more troublesome in moist grain. If stored grain has more than 14% moisture check it regularly.
8. Using aeration to cool down grain in the fall will reduce insect infestations. Insects do not develop in grain with temperatures below 18°C. Best grain temperature for long term storage is 5°C to 10°C.

The above program of sanitation and pest proofing usually prevents pest problems. However, inspect and sample grain regularly. Should an insect problem develop in storage, see OMAF Publication 229, *Insects in Farm Stored Grain*, for recommendations on fumigating. Agriculture Canada Publication 1595, *Insects and Mites in Farm Stored Grain in the Prairie Provinces* is also useful.

Precautions

When handling fumigants follow the safety directions given on the manufactured product. Always work in pairs. Wear the recommended gas mask. Remove livestock or poultry that are in the same building, especially if they are under the grain bin.

Some people experience allergic reactions to grain dust and/or molds. Dust masks or respirators will help prevent this when handling grain.

WEED CONTROL IN CEREAL CROPS

For weed control recommendations see OMAF Publication 75: *Guide to Chemical Weed Control.*

BEFORE
USING
ANY PESTICIDE
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CAREFULLY

FIELD BEANS AND FIELD PEAS

FIELD BEANS

CROP MANAGEMENT

White beans should be planted between May 20 and June 10 in areas of 2500 to 2900 heat units, and between June 5 and June 20 in areas with greater than 2900 heat units. Planting date of colored beans is dependent upon both variety and heat unit availability. Check with the seed distributor for planting recommendations. The correct date of planting will allow the crop to avoid hot dry weather during flowering and allow harvest during mid-September when favorable harvest conditions are most likely.

Row widths of 70-75 cm are standard for both white beans and colored beans when the bean crop is to be pulled and windrowed. Approximately 250,000 viable seeds per hectare should be planted for a white bean crop, which is a seeding rate of approximately 18 seeds per metre of row or 40 to 55 kg/ha, depending on the seed weight of the variety. Consult the seed distributor for seeding rate recommendations for colored beans.

Row widths of 18-36 cm are standard if the white bean crop is to be direct harvested. Recent testing suggests that 375,000 to 500,000 viable seeds per hectare should be planted to facilitate harvesting. When direct harvest is planned for fields with a history of white mould, a cultivar with a low white mould infection score should be chosen, and the crop should be planted in 36 cm rows.

Table 63. Field Bean Variety Recommendations

					Disease Reaction[2]		
Variety	Heat Unit Rating	Yield[1] t/ha	Days to maturity	100 Seed wt. (g)	White Mould Infection[3] (%)	Bean Common Mosaic Virus	Anthracnose Delta-race
				White Beans			
Northland	2500	1.9	91	17.9	19	R	S
Mitchell[4]	2550	2.2	90	19.3	30	R	S
Seafarer	2550	2.1	90	19.1	18	R	S
OAC Seaforth	2550	2.0	91	19.2	17	R	R
Midland	2650	2.3	94	16.2	32	R	S
Wesland	2700	2.3	94	19.2	27	R	S
Kentwood	2700	2.2	95	22.5	28	S	S
Harokent	2700	2.1	96	22.7	14	R	R
Suncrest	2700	2.3	96	20.0	32	R	R
Dresden[4]	2750	2.4	98	18.4	14	R	R
Crestwood	2800	2.7	98	22.4	15	R	S
Ex Rico 23	2800	2.6	100	20.2	13	R	S
OAC Rico	2800	2.3	103	19.3	17	R	R
Fleetwood	2900	2.5	99	18.7	34	R	S
Harofleet	2900	2.5	101	19.2	27	R	R
				Yellow Eyes			
Steuben	2850	2.1	100	43.5	12	S	S
Aresteuben[4]	2850	1.8	101	42.8	NA	S	R

1) Three year average over 21 tests except for Crestwood (two years) and Aresteuben (one year)

2) See also Disease and Insect Recommendations. R(resistant); S(susceptible)

3) Two year average over three tests except Mitchell, Suncrest and Dresden (one test)

4) Seed will be unavailable or in short supply until 1988.

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Table 64. Distributors for Field Bean Varieties

Variety	Distributor
Northland	W.G. Thompson and Sons Ltd.
Mitchell	Public variety
Seafarer	Public variety
OAC Seaforth	Public variety
Midland	W.G. Thompson and Sons Ltd.
Wesland	W.G. Thompson and Sons Ltd.
Kentwood	Public variety
Harokent	Public variety
Suncrest	Cooks, W.G. Thompson and Sons Ltd.
Dresden	Public variety
Crestwood	Cooks, W.G. Thompson and Sons Ltd.
Ex Rico 23	Public variety
OAC Rico	Public variety
Fleetwood	Public variety
Harofleet	Public variety
Steuben	Public variety
Aresteuben	Public variety

FIELD PEAS

CROP MANAGEMENT

Field peas are best adapted to areas with less than 2900 heat units. They are frost tolerant and should be seeded as early as cereals. For varieties with large and medium-sized seed, plant 170-200 kg/ha; for small-seeded varieties plant 130 kg/ha.

If peas have not been previously grown in the field, inoculate the seed with rhizobia.

For additional information see OMAF Factsheet *Field (Dry) Peas in Ontario*, Agdex 142/13.

Table 65. Recommended Field Pea Varieties and Description

Variety	Seed Size	Seed Colour	Maturity	Yield Index[1] (% of century)
Century	Large	Yellow	Medium	100
Lenca	Medium	Yellow	Medium	118
Tara	Medium	Yellow	Medium	94
Tipu (semi-leafless)	Medium	Yellow	Medium	88
Trapper	Small	Yellow	Early	91
Triumph	Medium	Green	Medium	84
Victoria	Medium	Yellow	Early	108

[1] *Two year average (1985-1986) from New Liskeard College of Agricultural Technology. Because of local adaptation, performance on your farm may differ from that shown.*

FERTILIZERS FOR FIELD BEANS AND PEAS

Nitrogen

Nitrogen fertilizers are not usually required for field beans and peas but where phosphate fertilizers are banded a small amount of nitrogen (10 kg N/ha) may improve the availability of the phosphate. Where field bean yields have been low due to bronzing or root rots, apply an additional 100 kg nitrogen per hectare before planting. Under these conditions nitrogen will increase yield but will not cure the bronzing or the root rot.

Phosphate and Potash

Phosphate and potash requirements for field beans and peas are presented in table 67. For information on use of this see *Soil Testing Section in Soils.*

Plant Analysis

For field beans sampling the top fully developed leaf (three leaflets plus stem) at first flowering is recommended. However plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results when the samples are not taken at flowering.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis Section* in *Soils*.

Table 66. Interpretation of Plant Analysis for Field Beans[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	4.0	5.5
Phosphorus (P)	%	0.15	0.5
Potassium (K)	%	1.2	2.5
Calcium (Ca)	%	—	5.0
Magnesium (Mg)	%	0.10	1.00
Boron (B)	ppm (ug/g)	10	55
Copper (Cu)	ppm	4	30
Manganese (Mn)	ppm	14	100
Zinc (Zn)	ppm	14	50

[1] *Values apply to the top fully developed leaf (3 leaflets plus stem) at first flowering.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Micronutrients

Zinc deficiency has been reported on field beans in Michigan but appears to be very rare in Ontario. Other micronutrient deficiencies have not been diagnosed in peas and beans. Beans are very sensitive to boron and should not be grown the year after rutabagas receiving boron.

Methods of Application

Fertilizer should not be placed in contact with bean or pea seeds. The fertilizer may be broadcast and plowed down or worked in before planting, or a planter with a separate attachment for fertilizer placement may be used to place the fertilizer 5 cm to the side and 5 cm below the seed. For further information see Table 11, *Maximum Safe Rates of Nutrients* in the *Soils* section.

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre

Kilograms per hectare x 0.4 = kilograms per acre.

Table 67. Phosphate and Potash Requirements for Field Beans and Peas Based on OMAF Soil Tests

Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required — kg/ha	Ammonium Acetate Potassium Soil Test (ppm)	Rating	Potash (K_2O_5)[1] Required — kg/ha
0 - 3		80	0 - 15		120
4 - 5		60	16 - 30		110
6 - 7	LOW	50	31 - 45	LOW	90
8 - 9		40	46 - 60		80
10 - 12		30	61 - 80		60
13 - 15	MEDIUM	20	81 - 100	MEDIUM	40
16 - 25	HIGH	0	101 - 120		30
26 - 60	VERY HIGH	0	121 - 150	HIGH	0
61 +	EXCESSIVE[2]	0	151 - 250	VERY HIGH	0
			251 +	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils). Example of fertilizer application: If a field bean crop is not manured and the soil tests are 9 for phosphorus and 85 for potassium, the phosphorus require is 40 kg/ha and the potash requirement 40 kg/ha (see above table). Ten kilograms of nitrogen are also recommended. These nutrients can be supplied by broadcasting or banding 170 kg/ha of 6-24-24 fertilizer.*

[2] *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may also increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

DISEASE AND INSECT CONTROL IN FIELD BEANS

(see also Pesticides section)

Seed Treatment

Follow the precautions under *Seed Treatments* in the *General Information on Pesticide Usage* section when applying any chemical seed treatment.

Seed treatments containing diazinon, lindane and a fungicide are required to protect large-seeded crops from seed maggots, wireworms and seed decay organisms. (See Precautions with Pesticides section).

Application of the insecticides alone may result in reduced germination. Diazinon is used to control seed maggots; lindane to control wireworms and the fungicide to control disease organisms. The combination seed treatment should be applied every year.

Combinations of diazinon, lindane and captan are available from seed suppliers in individual containers. Directions stated on the container should be followed with care; the mixing in the planter box must be thorough or germination will be reduced and insect control will be poor. For your protection while mixing the chemicals with the seed, use a wooden paddle and wear rubber gloves and a respirator. Do not breathe the dust stirred up during mixing.

DISEASES

General Preventative Measures

1. All equipment used for cleaning, conveying or planting of seed should be thoroughly washed with detergent to remove all soil. The equipment should then be disinfected with a quaternary ammonium compound (eg. Niagara HY-X) or sodium hypochlorite (eg. 10% Javex). Rinse off the disinfectant with clean water to limit rusting of treated surfaces.
2. Use a two-to-three-year rotation.
3. Do not apply manure containing bean refuse to land intended for beans.
4. Stay out of bean fields when the foliage is wet to avoid spreading diseases.

Bacterial Blight All bean varieties are susceptible to common bacterial blight but most are resistant to Halo Blight. The bacteria usually do not overwinter in the field but, to be safe, allow one year between crops. Almost all infections begin from infected seed. **Do not plant seed which has been harvested from diseased plants.**

Anthracnose The currently recommended varieties of white bean are resistant to alpha, beta and gamma races of anthracnose. Consult Table 63 for varieties resistant to the delta race.

The fungus survives from year to year on seed and on infected plant straw, in the soil and on farm machinery. Rainy weather favors this disease as spores are splashed from diseased areas and carried in wind-borne water droplets throughout the field. For varieties susceptible to the delta race, plant anthracnose-free seed. When the disease condition of the seed is not known, treat with DCT at the recommended rates. This product will not control anthracnose if seed is severely infested. DCT may not contain sufficient diazinon to control seed corn maggot when severe.

Root Rot and Bronzing (ozone damage) occur in almost every field every year. The amount of damage is related to the general health of the crop as well as to the amount of root-rotting organisms in the soil or ozone in the air. Beans which are not growing well have more injury from root rot and bronzing than vigorous beans.

Eliminating these diseases is impossible. Yield losses caused by them can be reduced by following good soil management practices.

1. Increase nitrogen levels; see Fertilizers for Field Beans and Peas.
2. Keep organic matter as high as possible.
3. Maintain or build up good soil tilth by not overworking the soil or working it when it is too wet.

White Mold (Sclerotinia) usually begins to appear by mid August. The fungus disease develops from windblown spores produced from small black bodies (sclerotia) that survive in the soil over winter. The sclerotia are found on and in stems and pods of infected plants and at harvest are scattered over the soil. These sclerotia are not toxic to livestock. Initial infection occurs on plant tissues such as older flowers or possibly lower leaves that have died from other causes. Infection of healthy pods, stems and leaves results from infected plant parts coming in contact with healthy plant tissues. Weather conditions, especially rainfall, play a critical role in disease development. In areas where disease is widespread, crop rotation has not given control. Spraying with fungicides is considered essential in fields with the following conditions.

— a past history of white mold;
— above average foliage growth;
— exposure to continuous wetness and air temperatures between 15 to 20°C (day and night temperatures) for more than 48 hours (fewer hours if temperatures are higher).

For most effective control, foliar sprays must be applied at first bloom prior to appearance of disease. Sprays applied after disease first appears do not control white mold effectively.

Table 68. White Mold Control

Fungicide	Product per ha
Benlate 50 W	1.7-2.25 kg
Rovral 50 W	1.0 kg-1.5 kg
Easout 70 W	1.75-2.25 kg
Botran 75 W	3.25 kg

W (wettable).

Do NOT feed treated bean refuse to livestock.

INSECTS

Green Cloverworm is a greenish caterpillar that feeds on bean foliage, causing holes in leaves and reducing yield. Shake worms from plants onto paper to count them. If more than five caterpillars are found per 30 cm of row, apply an insecticide as listed below:

Table 69. Cloverworm Control

Insecticide[1]	Product per ha	Days to Harvest
Thiodan 4 EC	1.4 L	2
*Guthion 240 SC	1.75-2.25 L	3

* *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

EC (Emulsifiable Concentrate);
SC (Sprayable Concentrate);

[1] *These insecticides are toxic to honey bees and growers must use appropriate caution. See Protect Honeybees section.*

Mexican Bean Beetles and Potato Leafhoppers cause damage some years. Growers should check the descriptions below and treat their plants when insects are causing damage.

Mexican bean beetles are oval in shape with 16 small black spots on their otherwise yellowish back. The larvae are easily identified by their yellow color and the presence of six rows of long branching, black-tipped spines.

Potato leafhoppers are pale green, wedged-shaped insects about 0.3 cm long. They are best identified by observing how they walk. They can walk equally well forwards, backwards and sideways when disturbed.

Leafhoppers are more likely to cause reductions in yield when they are numerous early in the season and the crop is under stress from drought. When control is necessary, apply one of the insecticides in the table. A second application may be necessary; recheck the fields.

Table 70. Mexican Bean Beetle and Leafhopper Controls

Insecticide	Product per ha	Days to Harvest	Comments
Cygon 480 E	0.7-1.0 L	7	Do not use straw for feed or bedding.
Thiodan 4 EC	1.4 L	2	
*Guthion 240 SC	2.25 L	3	
Malathion 500 EC	1.3-2.5 L		
Sevin XLR[2] 480 Su	1.25-2.5 L	3	Use lower rate for bean beetles.

* *Minimum period before reentry into treated area is 48 hours. See Reentry in Treated Areas section.*

[1] *E or EC (Emulsifiable Concentrate); SC (Sprayable Concentrate); Su (Suspension).*

[2] *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees foraging on flowers of peas and beans.*

Follow precautions applying to honeybees. See Protect Honeybees section.

Grasshopers Maintain weed-free headlands and fencerows. If grasshoppers become a problem, spray outer rows of the field.

Table 71. Grasshopper Control

Insecticide	Product per ha	Days to Harvest
Basudin 50 W	1.1 kg	14
Diazinon 50 WP	1.1 kg	14
Malathion 25 WP	3.4 kg	7
500 EC	1.7 L	
Sevin XLR[2] 480 Su	1.25-2.25 L	3

[1] *E or EC (Emulsifiable Concentrate); WP (Wettable Powder); Su (Suspension)*

[2] *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees foraging on flowers of peas and beans.*

Follow precautions applying to honeybees. See Protect Honeybees section.

WEED CONTROL IN FIELD BEANS AND PEAS

For weed control recommendations see OMAF Publication 75, *Guide to Chemical Weed Control.*

SOYBEANS

CROP MANAGEMENT

Soybeans should be planted from May 15 to May 30. later planting will cause marked yield decreases. Choose a variety that will mature every year in your locality. See Heat Units Available for Corn Production, Figure 1.

When you intend to sow fall wheat following a soybean crop, consider a soybean variety earlier than a full-season variety for your area.

When seeding, make allowance for variety seed-size differences. A seeding rate of 67 kg/ha (1 bu/ac) is adequate for all varieties in 36 to 71 cm rows. Eighteen centimetre rows are recommended under short growing season conditions. Adjust seeding rate upward for lower germination or for soils which crust badly. Uniform depth of seeding, 3 to 5 cm, is important.

Table 72. Seeding Rate

	Row Width (centimetres)			
	18	36	53	71
	Number of Seeds/Metre of Row[1]			
	10	15	21	29
Number of Seeds/Kilogram	Seeding Rate[2] (kg/ha)			
4000-5000 (Large Seeds)	154-123[3]	115-92	115-92	115-92
5000-6000	123-103	92-77	92-77	97-77
6000-7000	103-87	77-67	77-67	77-67
7000-8000 (Small Seeds)	87-78	67-58	67-58	67-58

[1] *18-cm row width calculations based on a stand of 500,000 plants per hectare. 36-cm and wider row width calculations based on a stand of 400,000 plants per hectare.*

[2] *Calculations are adjusted for 90% seed germination.*

[3] *kg/ha x .9 = lb/ac*

Inoculation

When soybeans are grown on land for the first time, inoculation with soybean rhizobia is essential for high yields. Under these conditions, soil-applied granular inoculants produce more consistent nodulation and higher yields than seed-applied powders. Therefore, granular inoculant is recommended on new soybean land, at rates from 5 kg/ha in wide rows up to 10 kg/ha in rows 18 cm apart.

Granular inoculant is applied through granular insecticide applicators on a corn planter, with delivery tubes brought forward to place the inoculant in the seed furrow. In a grain drill, the grass seed box can be used for granular inoculant with tubing added to drop the inoculant with the seed. With newer drills, the granular inoculant may be applied through the fertilizer hopper. After nodulated soybeans have been grown on a field, the use of granular inoculant is not recommended because it usually does not cause yield increases.

If soybeans have only been grown for one or two years, or if they have not been grown for several years, soybean seed should be inoculated with powdered peat inoculant to ensure nodulation. For growers using powdered inoculant, use of a sticker will ensure uniform adhesion to the seed. The seed treatment Anchor serves as a sticker as well as a fungicide.

As a remedial measure, if nodulation does not occur, apply 50 kg/ha of nitrogen after full flower.

Table 73. Soybean Variety Recommendations and Descriptions

Variety	Heat Units Required	Hilum Colour	Seeds per Kilogram	Phytophthora Root Rot Reaction % Plant Loss[1]	Distributor[2]
Maple Ridge[3]	2400	yellow	6490	20	SeCan members
Baron[3]	2450	dark brown	5680	10	W.G. Thompson & Sons Ltd.
Maple Amber[3]	2450	brown	5850	10	Public variety
Maple Isle	2500	yellow	5430	27	SeCan members
Maple Arrow	2600	brown	5570	14	Public variety
KG30	2600	dark brown	6760	22	Pride Brand Seed
Bicentennial	2600	brown	4890	6	SeCan members
OAC Scorpio	2600	yellow	5590	32	SeCan members
Apache[3]	2600	gray	5480	12	W.G. Thompson & Sons Ltd.
OAC Libra	2650	black	6260	16	SeCan members
KG60	2700	buff	5530	8	King Agro Inc.
Evans	2700	yellow	6020	21	Public variety
Maple Donovan	2750	buff	6850	18	SeCan members
0877	2750	light gray	6090	25	Pioneer Hi-Bred Ltd.
J081[4]	2750	yellow	5590	26	Jacques Seed Co.
OAC Aries	2750	dark brown	6330	24	SeCan members
Marathon	2750	yellow	5350	22	W.G. Thompson & Sons Ltd.
J82	2800	dark brown	6900	34	Jacques Seed Co.
Crusader	2850	yellow	6060	15	W.G. Thompson & Sons Ltd.

Table 73. Soybean Variety Recommendations and Descriptions *(cont'd)*

Variety	Heat Units Required	Hilum Colour	Seeds per Kilogram	Phytophthora Root Rot Reaction % Plant Loss[1]	Distributor[2]
Commander	2850	yellow	5350	15	W.G. Thompson & Sons Ltd.
1282	2900	buff	5420	18	Pioneer Hi-Bred Ltd.
Hodgson	2900	buff	5960	14	Public variety
OAC Pisces	2900	buff	6180	4	SeCan members
Galaxy	2900	buff	5810	9	W.G. Thompson & Sons Ltd.
KG71	2900	buff	6250	13	Pride Brand Seed
A1564	2900	yellow	5740	12	Maple Leaf Mills Ltd.
S1346	2900	yellow	5620	7	Northrup King Seeds Ltd.
KG82	2900	tan	5240	5	King Agro Inc.
S15-50	2900	gray	6760	6*	Northrup King Seeds Ltd.
A1895	2900	black	5920	4	Maple Leaf Mills Ltd.
B152	2900	yellow	5920	4*	Northrup King Seeds Ltd.
PS80	2900	yellow	6080	15	Pride Brand Seed
S14-60	2950	buff	6600	7	Northrup King Seeds Ltd.
A1937	2950	buff	6080	11	Maple Leaf Mills Ltd.
1677	3000	yellow	6730	22	Pioneer Hi-Bred Ltd.
Hawk	3000	black	5760	6	W.G. Thompson & Sons Ltd.
B203	3050	yellow	6330	5*	Northrup King Seeds Ltd.
A2187	3050	yellow	6140	13	Maple Leaf Mills Ltd.
B220	3100	yellow	5980	27	King Agro Inc.
Premier	3100	yellow	6260	8	Pride Brand Seed
Jewel	3100	yellow	6170	30	W.G. Thompson & Sons Ltd.
S23-03	3100	buff	5840	5	Northrup King Seeds Ltd.
Combat	3100	yellow	6240	3	W.G. Thompson & Sons Ltd.
Elgin	3100	black	5590	8	Public variety
G-3637	3100	black	5620	14	Funk Seeds
PS90	3100	yellow	5960	11	Pride Brand Seed
S24-24	3100	yellow	6240	2*	Northrup King Seeds Ltd.
UCO112	3100	brown-black	5440	8	United Cooperatives of Ontario
Corsoy 79	3150	yellow	6300	7*	Public variety
Harcor	3150	yellow	6090	21	Public variety
9271	3150	brown	5160	11	Pioneer Hi-Bred Ltd.
9292	3200	brown	5130	14	Pioneer Hi-Bred Ltd.
J103	3200	yellow	5680	22	Jacques Seed Co.
J231	3250	brown-black	4640	24	Jacques Seed Co.
A2943	3250	brown-black	6200	7	Maple Leaf Mills Ltd.
A3127	3300	black	6650	7	Maple Leaf Mills Ltd.

**Varieties with multi-race resistance to the prevalent races of the Phytophthora root rot organism.*

[1] *Three-year average (1984-86) in a field heavily infested with Phytophthora. Not all races of Phytophthora root rot are found at this site. Thus the relative ranking of varieties for plant loss may differ in fields that have other races present.*

[2] *See Distributor Addresses in General Section.*

[3] *Metribuzin should not be used on Maple Ridge, Baron, Maple Amber, Apache.*

[4] *This variety was not tested in 1986. Values shown are 3-yr averages from 1983-5, calculated as a % of values for other varieties, and multiplied by 1984-86 averages.*

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Table 74. Agronomic Data

Testing Areas	Variety	Heat Unit Rating	Yield[1] (t/ha)	Yield[2] Index (%)	Days from planting to maturity	Plant Height (cm)	Lodging 1-standing 5-flat
3 year average of 10 trials at Brussels, Elora, Inkerman and Ottawa	Maple Ridge	2400	2.4	89	108	61	1.3
	Baron	2450	2.5	93	110	70	1.8
	Maple Amber	2450	2.4	89	111	73	1.7
	Maple Isle	2500	2.4	89	114	62	1.5
	Maple Arrow	2600	2.6	96	118	76	2.0
	KG 30	2600	2.7	100	118	75	1.8
	Bicentennial	2600	2.7	100	120	80	2.7
	OAC Scorpio	2600	2.8	104	122	81	2.5
	Apache	2600	2.8	104	124	73	1.8
	OAC Libra	2650	2.8	104	128	85	2.8
	Maple Donovan	2750	2.9	107	129	82	2.1
	0877	2750	2.9	107	131	88	2.4
	Average yield		2.7				
3 year average of 9 trials at Centralia, Woodstock, London and Smithfield	Maple Arrow	2600	2.6	93	111	70	1.4
	Bicentennial	2600	2.8	100	114	74	1.9
	Apache	2600	2.7	96	116	70	1.3
	OAC Libra	2650	2.7	96	118	79	1.9
	KG60	2700	3.0	107	120	68	1.6
	Evans	2700	2.8	100	121	81	1.8
	0877	2750	3.0	107	121	80	1.7
	J081	2750	2.8	100	121	85	1.3
	OAC Aries	2750	2.8	100	121	90	1.9
	Marathon	2750	2.9	104	121	79	1.6
	Maple Donovan	2750	2.8	100	122	78	1.5
	J82	2800	2.6	93	122	83	1.6
	Crusader	2850	2.8	100	123	84	1.8
	Commander	2850	2.8	100	124	89	1.9
	1282	2900	2.9	104	126	88	1.8
	Hodgson	2900	2.8	100	126	86	1.5
	OAC Pisces	2900	2.7	96	126	79	1.9
	Galaxy	2900	2.8	100	129	86	1.5
	S1346	2900	2.9	104	130	75	1.5
	A1564	2900	2.8	100	131	91	1.8
	KG82	2900	3.0	107	131	86	1.6
	Average yield		2.8				
3 year average of 11 trials at Fingal (Silt Loam), Talbotville (Clay Loam), Ridgetown (Clay Loam) and Inwood (Clay)	1282	2850	3.1	94	124	77	1.9
	Crusader	2850	3.2	97	124	81	2.3
	Hodgson	2900	3.2	97	125	80	1.7
	KG71	2900	3.2	97	127	71	1.6
	A1564	2900	3.2	97	127	89	2.2
	S15-50	2900	3.2	97	127	85	1.7
	A1895	2900	3.3	100	128	75	1.8
	B152	2900	3.5	106	128	72	1.6
	S1346	2900	3.2	97	128	71	1.3
	A1937	2950	3.4	103	129	82	2.3
	S14-60	2950	3.2	97	129	74	1.6
	1677	3000	3.2	97	130	77	2.0
	Hawk	3000	3.2	97	131	77	3.2
	Elgin	3100	3.4	103	134	77	2.2
	Premier	3100	3.3	100	135	82	2.0
	B220	3100	3.3	100	135	85	1.8
	Jewel	3100	3.4	103	135	76	1.7
	9271	3150	3.4	103	137	77	1.6
	Corsoy 79	3150	3.3	100	138	94	2.7
	Average yield		3.3				

Table 74. Agronomic Data ***(cont'd)***

Testing Areas	Variety	Heat Unit Rating	Yield[1] (t/ha)	Yield[2] Index (%)	Days from planting to maturity	Plant Height (cm)	Lodging 1-standing 5-flat
3 year average of 10 trials at Chatham (Loam), Woodslee (Clay), and Malden (Loam)	A1564	2900	3.1	94	116	78	1.6
	B152	2900	3.2	97	116	62	1.2
	PS 80	2900	3.0	91	116	79	1.6
	Hodgson	2900	3.2	97	117	74	1.4
	S1346	2900	3.0	91	117	62	1.1
	S14-60	2900	3.2	97	118	68	1.2
	1677	3000	3.0	97	118	69	1.6
	A1937	3000	3.3	91	119	76	1.6
	Hawk	3000	3.2	100	119	71	2.0
	B 203	3050	3.2	97	121	73	1.5
	A2187	3050	3.3	97	122	76	1.2
	B 220	3100	3.2	97	123	75	1.3
	Premier	3100	3.2	97	123	74	1.5
	Jewel	3100	3.3	100	124	68	1.4
	S23-03	3100	3.4	103	124	78	1.5
	Combat	3100	3.2	97	125	83	1.7
	Elgin	3100	3.4	103	125	72	1.7
	G 3637	3100	3.3	100	125	91	2.0
	PS 90	3100	3.3	100	125	82	1.5
	S24-24	3100	3.3	100	125	83	1.9
	UC0112	3100	3.4	103	125	76	1.3
	Corsoy 79	3150	3.3	100	125	88	1.9
	Harcor	3150	3.2	97	126	85	2.0
	9271	3150	3.5	106	126	71	1.2
	9292	3150	3.5	106	127	70	1.1
	J 103	3200	3.3	100	128	73	1.4
	J 231	3200	3.4	103	128	75	1.3
	A2943	3250	3.4	103	134	85	1.2
	A3127	3300	3.5	106	136	81	1.4
	Average yield		3.3				

[1] *t/ha = 1 tonne/hectare = 15 bu/ac.*

[1] *For each test Yield Index is expressed as a percentage of the average yield of all recommended varieties grown in that test area.*

FERTILIZERS FOR SOYBEANS

Nitrogen

Where soybeans have not been grown recently, the seed should be inoculated with nitrogen fixing bacteria before seeding. See *Inoculation* in the *Soybean Crop Management section.*

Phosphate and Potash

Phosphate and potash requirements for soybeans are given in table 75. For information on use of this table see *Soil Testing Section* in *Soils.*

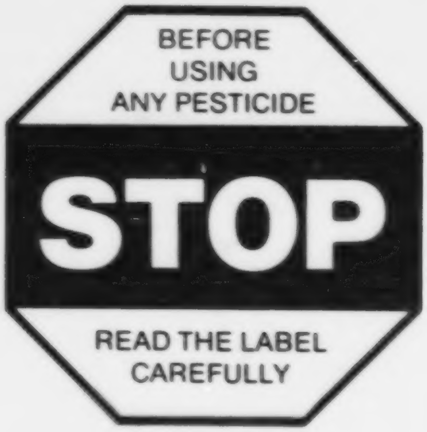


Table 75. Phosphate and Potash Requirements for Soybeans Based on OMAF Soil Tests

Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required - kg/ha	Ammonium Acetate Potassium Soil Test (ppm)	RATING	Potash (K_2O_5)[1] Required - kg/ha
0 - 3		80	0 - 15		120
4 - 5		60	16 - 30		110
6 - 7	LOW	50	31 - 45	LOW	90
8 - 9		40	46 - 60		80
10 - 12		30	61 - 80		60
13 - 15	MEDIUM	20	81 - 100	MEDIUM	40
16 - 25	HIGH	0	101 - 120		30
			121 - 150	HIGH	0
26 - 60	VERY HIGH	0	151 - 250	VERY HIGH	0
61+	EXCESSIVE[2]	0	251+	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils). Example of fertilizer application: If a soybean crop is not manured and the soil tests are 9 for phosphorus and 85 for potassium, the phosphate requirement is 40 kg/ha and the potash requirement 40 kg/ha (see above table). Ten kilograms of nitrogen are also recommended. These nutrients can be supplied by broadcasting or banding 170 kg/ha 6-24-24 fertilizer.*

[2] *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may also increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Plant Analysis

For soybeans, sampling the top fully developed leaf (3 leaflets plus stem) at first flowering is recommended. However plants suspected of having a nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results if the samples are not taken at flowering.

For more information on *Plant Analysis* see *Plant Analysis* section in *Soils*.

Table 76. Interpretation of Plant Analysis for Soybeans[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen (N)	%	4.0	6.0
Phosphorus (P)	%	0.15	0.50
Potassium (K)	%	1.2	2.5
Calcium (Ca)	%	—	3.0
Magnesium (Mg)	%	0.10	1.00
Boron (B)	ppm (ug/g)	20	55
Copper (Cu)	ppm	4	30
Manganese (Mn)	ppm	14	100
Molybdenum (Mo)	ppm	.5	5.0
Zinc (Zn)	ppm	12	80

[1] *Values apply to the top fully developed leaf (3 leaflets plus stem) at first flowering.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Micronutrients

Manganese is the only micronutrient deficiency diagnosed in soybeans in Ontario although zinc deficiency may show up in the future where the surface soil has been lost by erosion.

With Manganese deficiency, the upper leaves range from pale green (slight deficiency) to almost white (severe deficiency) while the veins remain green. In addition to deficiency symptoms both soil tests and plant analyses are useful in predicting where manganese deficiencies are likely to occur. Both are available at the OMAF soil testing and plant analysis laboratory.

Correct the deficiency as soon as detected by spraying the foliage with 2 kg of manganese/ha from manganese sulfate (8 kg of manganese sulfate/ha) or 0.4 kg of manganese/ha in chelated form in 200 L of water.

A "spreader-sticker" in the spray is recommended for materials other than chelates. If the deficiency is severe, a second spray may be beneficial.

Never use spray equipment which has been used for spraying hormone-type herbicides such as 2,4-D. Beans are very sensitive to this type of herbicide.

Soil applications is not a recommended way to apply manganese regardless of the source because of the large amounts required. Manganese chelates should not be applied to the soil.

For further details on manganese deficiency and on methods of applications refer to OMAF Factsheet, *Manganese in Soybeans and Small Grain Production*, Agdex 100/531.

Methods of Application

Fertilizer should not be placed in contact with soybean seeds. The fertilizer may be broadcast and plowed down or worked into the soil either in the fall or spring; or a planter with a separate attachment for fertilizer placement may be used to place the fertilizer 5 cm to the side and 5 cm below the seed. For further information see table 11, *Maximum Safe Rates of Nutrients* in the *Soils* section.

DISEASE AND INSECT CONTROL IN SOYBEANS

(see also Pesticides section)

Seed Treatments

Follow the precautions under *Seed Treatments* in *General Information in Pesticide Usage* section, when applying any chemical seed treatment.

Seed treatments are recommended for control of seed decay, damping-off, and seedling blight which are caused by various seed-borne and soil-borne fungi. These diseases reduce germination, plant stand and yield.

Seed treatments are recommended also for control of seed maggots and wireworms in areas where these insects are a problem. Seed maggots usually are damaging on lighter soils high in organic matter. Wireworms may be a problem in soybeans that follow sod or pasture. The recommended insecticides are Diazinon and Lindane, but they can cause seedling injury when one or both are used. The addition of a fungicide such as captan makes these products safer on soybeans seed and in addition controls seed decay and seedling diseases.

Among the products containing Diazinon, Lindane and captan, only Agrox B-3 contains sufficient captan fungicide to be used on untreated soybean seed. Agrox D-L Plus, Co-op D-L + C and Drillbox D-L + C contain about half as much captan as needed, and therefore should only be used on seed previously treated with Anchor, captan, Vitaflo-280 or Vitavax powder. In areas where insect problems are minimal, use seed treatments containing fungicide only, such as captan, Anchor, Vitaflo-280 or Vitavax powder.

Phytophthora Root Rot is a potential problem in heavy clay soils in southwestern Ontario. The disease has also been observed in central and eastern Ontario. Seedlings may be killed prior to emergence or plants may be killed any time before maturity. A reddish discolouration extending from the roots to the lower nodes is evident on the stems of wilted plants. Dead plants may occur as either a few in a row or as patches in low areas of fields. Control of Phytophthora root rot requires a combination of soybean variety selection and good soil managements.

Soybean varieties with resistance or tolerance to Phytophthora root rot are available (Table 73). Some varieties have both resistance and tolerance.

1. Resistant varieties. The Phytophthora fungus is present in Ontario soils as a series of races (or "strains"). Resistance in any one soybean variety is effective against some but not all of the races. Root rot is controlled in a particular field when the variety grown is resistant to all of the Phytophthora races that happen to be present in that field. Resistance will "break

Table 77. Soybean Seed Treatments

Product	Active Ingredients	Formulation[1]	Diseases Controlled		
			Phomopsis Seed Mold	Rhizoctonia Damping Off	Other Seed Decay and Seedling Blight[2]
Insect and Disease Control					
Bin-run (Untreated) Seed					
Agrox B-3	diazinon + lindane + captan	P-DB	—	—	+
Seed Pretreated with Fungicide					
Agrox D-L Plus	diazinon + lindane + captan	P-DB	—	—	+[3]
Co-op D-L + C	diazinon + lindane + captan	P-DB	—	—	+[3]
Drillbox D-L + C	diazinon + lindane + captan	P-DB	—	—	+[3]
Disease Control					
Anchor	carbathiin + thiram	L	+	+	+
Captan	captan	F or P	—	—	+
Vitaflo -280	carbathiin + thiram	S	+	+	+
Vitavax Powder	carbathiin + thiram	P-DB	+	+	+

[1] *P-DB (Powder Drill Box); S (Flowable Suspension); F (Flowable); P (Powder); L (Liquid);*

[2] *Caused by other soil fungi especially pythium.*

[3] *Effective only when applied to seed already treated with captan.*

+ *Recommended for disease listed.*

— *NOT recommended*

down", however, should another race appear to which the variety is not resistant. If this occurs, use a tolerant variety.

2. Tolerant varieties. Some disease develops in these varieties when grown in infested soils, regardless of which races of Phytophthora are present. However yields of tolerant varieties usually are not seriously reduced by the disease.

Any soil management practice which reduces soil compaction or waterlogging will decrease the incidence of Phytophthora root rot. On clay soils where the disease may be a problem, the following procedures are recommended.

a. Choose a variety with a low percentage of infected plants (see Table 73).
b. Prepare seedbeds by fall plowing and spring tillage.
c. Do not plow or disk when the soil is wet.
d. Plow in crop residues or manure to improve soil structure.
e. Include crops in a rotation which improve soil structure.
f. Inspect each soybean field for dead plants in late July or early August to determine whether or not the variety has enough resistance/tolerance to provide adequate protection under local conditions.

Rhizoctonia Root Rot has been found in most of the soybean growing areas of southwestern Ontario. Symptoms of the disease are very similar to plants infected with Phytophthora, except reddish lesions produced on roots and lower stems seldom extend above the soil line. There are no commercial varieties that are tolerant to Rhizoctonia.

DISEASES

Phomopsis seed mold (Pod and Stem Blight) develops near harvest when weather is warm and wet. Fine cracks usually develop in the coat of the infected seed, especially near the hilum. A white or grey mold may be visible on the seed surface. The yield, grade, viability and vigour of the seed can be reduced. Whenever possible, grow full-season varieties that mature during the cool weather late in the growing season. Varieties that are short-season for an area tend to mature earlier when conditions are warmer and more favorable for seed mold. Seed treatment (Table 77) usually increases germination and emergence of seed. However distorted seed with visible fungal growth often fails to germinate, even when treated. Rotating soybeans with other crops and plowing under crop residues help to reduce disease severity.

Powdery Mildew develops on the leaves usually in August and September. White powdery growth of the mildew fungus appears on the upper surface of the leaf. The seeds do not become infected. Yield losses usually occur only when outbreaks of powdery mildew begin early, in July, and remain severe until maturity. Cool cloudy weather favors the disease.

Downy Mildew appears as yellow, and later, brown spots on the leaves during August and September. In moist weather a pale blue to gray, downy growth of the mildew fungus appears on spots on the lower leaf surface. Severely affected leaves may drop prematurely. Whitish growth of the fungus may encrust the seeds, even within pods that appear healthy. Varieties differ in susceptibility; the variety **Evans** is highly susceptible, but **Maple Arrow** *has considerable* resistance. Rotate soybeans with other crops and plow under crop refuse.

White Mold may cause damage to soybean under cool, wet conditions. Stems, pods and leaves infected with white mold are pale brown and water-soaked in appearance. Frequently a white cotton-like growth and small dark bodies (sclerotia) can be seen on or within stems of diseased plants. The sclerotia survive many years in soil. In summer, disease arises from airborne spores produced on the sclerotia. Crop rotation may be useful for disease control in areas where white mold is uncommon. White mold is more likely to occur in soybeans following any bean, sunflower or canola crop in which white mold was present in previous years. Avoid this crop sequence if possible. In areas where white mold is common, however, the disease may appear in spite of crop rotation because of windblown spores from other fields Some differences in disease severity in varieties have been noted. No resistant varieties have been identified but field observations indicate that early varieties in a geographic area are less prone to an epidemic than later varieties. Similarly, varieties with greater lodging resistance tend to be more resistant to white mold. For soybean fields with a history of severe white mold infection, producers should consider planting varieties which require 200-300 fewer heat units than normally available and which possess superior resistance to lodging.

INSECTS AND MITES

Mites These are occasional pests of soybeans. The adults are tiny, rounded, eight-legged and usually red. Both the adults and the immatures feed on plant juices from the undersides of leaves. Their feeding causes yellowing, curling and bronzing. A close examination will show fine webbing on the lower surface of the leaves and the tiny mites with two dark spots.

There are many generations a year. As grain and other crops mature the mites can move into soybean fields. Four or more mites per leaf or one severely damaged leaf per plant warrant chemical control. If rain is forecast, spraying should be delayed because the rain will usually reduce the number of mites to unimportant levels.

For chemical control, use Cygon 480E at rates listed in Table 70 for Mexican Bean Beetle and Leafhopper Control in the *Field Bean* section.

Insect damage is seldom enough to cause soybean yield losses in Ontario. Green cloverworms may be prevalent in some years. Control measures for green cloverworms and grasshoppers are listed in Tables 69 and 71 in the *Field Bean* section. Follow precautions for handling chemicals. See *Pesticides* section.

Caution: Soybeans can be an important honey source and are well used by honeybees. Please refer to notes on bee poisoning and use appropriate caution.

WEED CONTROL IN SOYBEANS

For weed control recommendations see OMAF Publication 75, *Guide to Chemical Weed Control.*

SPRING CANOLA AND WINTER RAPESEED

SPRING CANOLA

CROP MANAGEMENT

Spring canola is a cool-season crop suited to areas with less than 2700 heat units.

Seeding should be done as early as soil conditions permit. Planting time should be late April to early May. Yield reductions will occur if seeding is delayed. Plant 4 to 5 kg/ha of seed in 18 cm rows (15 to 20 seeds per metre) with a grain drill or Brillion-type seeder into a fine, firm seedbed. Planting depth should be 2 to 3 cm if there is adequate moisture, and deeper if necessary to plant in moisture, but not deeper than 4 cm. Seed should be mixed with an insecticide for flea beetle control before calibrating the drill.

Canola is highly susceptible to phenoxy herbicides such as 2,4-D and MCPA. Be sure spraying equipment is cleaned out thoroughly before using on canola.

Spring canola should be swathed when 25% of the seeds in pods from the middle portion of the plants have changed colour from green to red or brown. Leave as long a stubble as possible. Swathing when the crop is moist aids flow through the swather. Canola in the swath matures in 5 to 10 days under ideal weather. Seed can be marketed at 10% moisture but for long-term storage 8% moisture is recommended. Under good drying conditions, moisture content drops rapidly and combining can begin at about 13% moisture.

For additional information see OMAF Factsheet, *Spring Canola in Ontario*, Agdex 149/10.

VARIETY SELECTION

Argentine-type varieties are recommended for most areas with less than 2700 heat units. Polish-type varieties such as Candle and Tobin normally yield less than Argentine-type varieties and are only recommended for areas of northern Ontario where Argentine-type varieties do not mature regularly.

OAC Triton is an Argentine-type recommended in Ontario. It is resistant to triazine herbicides (see Weed Control in Canola) which can be used to control wild mustard and other weeds without damaging the crop. Consider growing OAC Triton in fields that have a mustard problem because mustard seed cannot be cleaned out of canola and more than 5% contamination can mean rejection of the canola by elevators or crushers.

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre

Kilograms per hectare x 0.4 = kilograms per acre.

Table 78. Recommended Spring Canola Varieties[2]

Variety	Days from Planting to Maturity	Yield[1,2] (t/ha)	Lodging 1 = standing 5 = flat	Distributor
Argentine Type				
Westar	99	2.4	2.1	SeCan Members
Global	105	2.6	1.4	Bonis and Co. Ltd.
Hanna	104	2.3	1.7	W.G. Thompson & Sons Ltd.
OAC Triton	103	1.8	2.6	SeCan Members
Polish Type				
Tobin	88	2.1	1.9	SeCan Members
Candle	89	1.9	2.1	Public Variety

[1] *1 t/ha = 893 lb/ac.*

[2] *Values shown are averages of 23 trials over 3 years except for Polish type, which are averages of 19 trials over 3 years.*

FERTILIZERS FOR SPRING CANOLA

Nitrogen

Nitrogen fertilizer recommendations for canola are based on expected yield and adjusted downward if manure was applied, or if the previous crop contained legumes such as alfalfa (see tables 4 and 5).

Table 79. Nitrogen Requirements for Spring Canola

Price Ratio[2]	Expected Yield[1] - t/ha 1.5	2	2.5	3
	Most profitable nitrogen application[3] (kg N/ha)			
500	125	150	165	175
400	100	130	150	160
300	60	100	125	140

[1] *t/ha = 893 lb/acre*

[2] *To use the table, the price of canola must be known or estimated. Canola at $210/t and nitrogen at $.70/kg (see table 13) results in a price ratio of 300 (210 ÷ 0.70). At these prices and an expected yield of 2.0 t/ha you should use 100 kg/ha of nitrogen.*

[3] *Nitrogen rates should be adjusted downward if the preceding crop was a legume sod (see Nitrogen Adjustment for Legumes Plowed Down section) or if manure is applied (see Manure Section in Soils).*

Phosphate and Potash

Phosphate and potash requirements for canola are given in table 80. For information on use of this table see *Soil Testing Section Soils* section.

Table 80. Phosphate and Potash Requirements for Spring Canola Based on OMAF Soil Tests

Sodium Bicarbonate Phosphorus Soil Test (ppm)	Rating	Phosphate (P_2O_5)[1] Required — kg/ha	Ammonium Acetate Potassium Soil Test (ppm)	Rating	Potash (K_2O)[1] Required — kg/ha
0 - 3		70	0 - 15		70
4 - 5	Low	60	16 - 30	Low	50
6 - 7		50	31 - 45		40
8 - 9		30	46 - 60		30
10 - 12		20	61 - 80		20
13 - 15	Medium	20	81 - 100	Medium	20
16 - 20		0	101 - 120	High	0
21 - 25		0	121 - 150		0
26 - 30	High	0	151 - 180	Very High	0
31 - 40		0	181 - 210		0
41 - 50	Very High	0	211 - 250		0
51 - 60		0	215 +	Excessive[2]	0
61 +	Excessive[2]	0			

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure section in Soils).*

[2] *Excessive ratings may cause reduced yield or quality of the crop.*

DISEASE AND INSECT CONTROL IN SPRING CANOLA

(see also Pesticides section)

Seed Treatment

Canola seed should be treated with a combination of fungicide and insecticide. The fungicide is required to control seed-borne and early soil-borne diseases, especially blackleg, seed decay, damping-off and seedling blight. Insecticides are to control flea beetles on emerging canola. Seed may have been commercially treated. Untreated seed should be treated by the grower. Use the following at rates recommended on the label.

Table 81. Canola Seed Treatments

Seed Treatment	Formulation[1]	Fungicide	Insecticide
Vitavax RS	F	3.3% carbathiin 6.6% thiram	50% lindane
Gammasan +	P	6% benomyl 10% captan	50% lindane

[1] *F(Flowable); P(Powder).*

DISEASES

White mold (Sclerotinia) is characterized by bleached stem lesions, hard black bodies (sclerotia) of the white mold fungus inside the stems, and premature ripening of the plants. The disease is often a problem when canola follows canola, white beans, soybeans or sunflowers. Use clean seed and rotations of at least four years including unaffected crops such as corn, wheat, barley or oats. Treatment with a fungicide may be advisable when conditions favor white mold but the fungicide must be applied **before** symptoms appear. The risk of white mold is high when the disease developed in previous crops, when the canola stand is dense and vigorous, and when several days of wet weather precedes the early flowering stage. Fungicides should be applied at the 20 to 30% bloom stage of canola, in a minimum of 80 L/ha of water with ground equipment, or 45 L/ha of water with aerial application.

Blackleg (Phoma) Blackleg was noticed in several Ontario spring canola fields in the summer of 1986. Refer to Disease section, Winter Rapeseed.

INSECTS

Flea beetles Two species of flea beetle attack canola. The striped flea beetle is about 1.5 mm long and has two cream-colored stripes along its back. The crucifier flea beetle is entirely bluish-black and about the same size. Flea beetles jump when disturbed, thus their common name. The adults eat holes through leaves. Larvae feed on the roots of canola and other cruciferous plants but are not considered damaging.

Both kinds of flea beetle overwinter as adults and can attack canola in the spring after germination. Damage is most severe during the initial three weeks following germination, when young seedlings are killed or seriously damaged. Feeding on the foliage continues during the season but more mature plants are less severely affected. Severe infestations in western Canada have caused 50% reductions in yield. The full extent of damage in Ontario is still unknown.

Control measures should be directed against the beetles during the early stages of seedling growth. Seed treatments (Table 81) should always be used because they provide protection from seed and soil born diseases and protect the young seedlings from flea beetles. (See the preceding section for information on seed treatments.) However, flea beetles can attack suddenly after the effect of the seed treatment is gone so a granular applied with the seed (Table 82) is also recommended. This combination of seed treatment and granular at planting provides the best protection. Heavily infested areas also may require a foliar spray to control flea beetles. Check the seedling fields regularly, especially along weedy borders. More severe damage is expected in such areas because of the proximity of the overwintering sites of the beetles.

Table 82. Flea Beetle Control

	Product per ha	Days to Harvest
Seed-furrow application:		
Counter 5G	5.5-11 kg	Planting time only
Furadan CR-10G	2.8 kg	
Post-emergent spray:		
Cymbush 250 EC	140 mL	30
Ripcord 400 EC	50 mL	30
**Decis 2.5 EC	200-300 mL	14
*Furadan 480 F	150-275 mL	60
*Guthion 50 WP	150-275 g	30
240 SC	275-550 mL	30
Sevin XLR 480 Su	500 mL	Within 4 weeks of emergence

[1] *G (Granular); F (Flowable); WP (Wettable Powder); SC (Sprayable Concentrate); EC (Emulsifiable Concentrate); Su (Suspension); CR (Special formulation for Canola Rape)*

**Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

Diamondback Moth The adult is a small light brown moth about 1 cm long. It is best identified by the white diamond-shaped markings along the back when the wings are at rest. Apparently this pest does not over-winter in Ontario. The severity of attack is dependant on the number of moths carried into Ontario each spring on weather systems.

Damage is caused by the larvae which are light green with brown heads and are about 1 cm long when mature. There are three or four generations in Ontario. They feed on the foliage and when numerous they will feed on the pods. This damage results in premature senescence and shattering of pods at harvest.

Table 83. Diamondback Moth Control

Product	Product per ha	Days to Harvest
Dylox[2] 80% SP	1.5 kg	21
420 L	2.75 L	21
*Guthion 50 WP	275-550 g	30
240 SC	.55-1.25 L	30

[1] *SP (Soluble Powder); L (Liquid); WP (Wettable Powder); SC (Sprayable Concentrate).*

[2] *Use Dylox if canola is in bloom because it is less hazardous to bees.*

**Minimum period before reentry into treated area is 48 hours. See Reentry into Treated Areas.*

Caution: Canola is a valuable honey source and is well used by honeybees. Bees aid in pollinating the crop. Applications of insecticide should be kept minimal while the crop is in bloom. See Protect Honeybees Section and take appropriate caution.

WEED CONTROL IN CANOLA

For weed control recommendations, see OMAF Publication 75: *Guide to Chemical Weed Control.*

WINTER RAPESEED

CROP MANAGEMENT

Under good management, winter rapeseed has greater yield potential than spring canola. Winter rapeseed is best suited to areas with good winter snow cover, low risk of ice accumulation and moderate climate.

Winter rapeseed grows best on loam or sandy-laom soils. Poorly drained soils and heavy clay soils should be avoided since root heaving may occur.

Seeding should be done August 15-30 (Aug. 20-Sept. 10 in Kent and Essex Counties) into a level, firm, moist seedbed. Plant 4 to 5 kg/ha of seed in 18 cm rows (15 to 20 seeds per metre) with a grain drill. Broadcast seeding is recommended only if soil fertility and tilth are optimal. Plant to a depth of 2 to 3 cm or to moisture, but do not exceed 4 cm. Seed should be mixed with an insecticide for flea beetle control before planting equipment is calibrated.

Winter rapeseed is highly susceptible to phenoxy herbicides such as 2,4-D and MCPA and is also susceptible to triazine herbicides. Swath when 50-60% of the seeds in pods from the middle portion of the plants have changed from green to black or direct-combine when seed moisture is 10% or lower, unless drying facilities are available. Winter rapeseed in the swath will be ready to combine in 5 to 10 days under good weather conditions. Seed can be marketed at 10% moisture but for long-term storage 8% moisture is recommended.

VARIETY SELECTION

There are no winter canola varieties licensed in Canada. The Argentine-type cultivar **Tandem** is approximately 10 micromoles over the established 'canola' standard of 30 micromoles of glucosinolates per gram of oil-free meal. Tandem, from King Agro Inc., is the only licensed winter rapeseed variety available in Canada and will be replaced when a suitable 'canola' quality cultivar is licensed.

FERTILIZERS FOR WINTER RAPESEED

Nitrogen

Fall Application

Apply 25 kg/ha of nitrogen in the fall. If the land was fallowed for one or more months before planting, or if forage legumes were plowed down, or manure applied before planting, no fertilizer nitrogen should be applied.

Spring Application

The rate for spring application of nitrogen is given in Table 84.

Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

Table 84. Spring Nitrogen Requirements for Winter Rapeseed

	Expected Yield[1] - t/ha		
Price Ratio[2]	2	3	4
	Most profitable nitrogen application (kg N/ha)		
500	180	210	220
400	160	195	210
300	125	170	195

[1] *t/ha = 893 lb/ac*

[2] *To use this table, the price of canola must be known or estimated. Canola at $210/t and nitrogen at $.70/kg (see table 13) results in a price ratio of 300 (210 ÷ 0.70). At these prices and an expected yield of 3 t/ha you should use approximately 170 kg/ha of nitrogen.*

Phosphate and Potash

For Phosphate and potash recommendations see section on *Fertilizers For Spring Canola.*

DISEASE AND INSECT CONTROL IN WINTER RAPESEED

Seed Treatment

Refer to *Seed Treatment section, Spring Canola.*

DISEASES

Blackleg (phoma) Blackleg was found in 92% of winter rapeseed fields surveyed in the summer of 1986. A few fields had severe disease that contributed to a yield loss of up to 35%. The first symptoms appear on cotyledons or leaves as round to irregular (1-2 cm), white to buff-coloured lesions dotted with numerous small, black fruiting bodies (pycnidia). As the season progresses, the fungus may spread to the stem and crown of the plant producing a canker (often containing pycnidia) that can girdle the stem. Severely infected plants ripen prematurely and have a black to grey discolouration at the base of the stem or crown. Seeds of severely infected plants are small, shrivelled and may be infected with the fungus. To control the disease, obtain seed from a reliable seed source and treat seed with a fungicide (Table 81). Use a 4-year rotation with crops other than crucifers. Beware of planting rapeseed adjacent to fields of previous rape since air-borne spores may be released from old crop stubble for up to 3-4 years. Efficient plough-down of stubble and control of volunteer rape and cruciferous weeds will help to reduce disease levels.

White mold (Sclerotinia) Refer to *Disease section, Spring Canola.*

Turnip Mosaic Virus (TuMV) has become a significant problem in some areas where winter rapeseed is grown. Infestation takes place in the fall, and causes leaf mottling (yellow or light green areas surrounded by normal green colour), and wrinkling or puckering of the leaf tissue between the veins. Spring growth is slow. Severely infected plants are stunted, twisted, and generally light green to yellow in color. Pods are distorted and a significant proportion of the seed are poorly filled. The disease appears to be more severe in areas where other cruciferous crops are grown, and in fields where pressure from weeds and volunteer cereals is high. Volunteer crops of winter rapeseed often have high levels of TuMV infections. Early planting may be helpful in increasing winter survival of the crop in some areas, but appears to also increase the severity of TuMV where the disease is present. Only minor levels of TuMV infection have been observed in spring canola.

INSECTS

Flea beetles Refer to seed-furrow application in the *Insect section, Spring Canola.* Flea beetle damage is generally limited to the fall period in winter rapeseed.

WEED CONTROL IN WINTER RAPESEED

For weed control recommendations, see OMAF Publication 75: *Guide to Chemical Weed Control.*

BEFORE
USING
ANY PESTICIDE
STOP
READ THE LABEL
CAREFULLY

GENERAL INFORMATION ON PESTICIDE USAGE

Brands of a pesticide from different companies often have different concentrations of the same chemical in them. Consequently, if you use one with a concentration different from that listed in the recommendations in this publication, you will need to adjust the rate of application so that you will be applying the same amount of actual chemical (active ingredient).

PRECAUTIONS WITH ALL PESTICIDES

Read the following points before using any pesticides:

1. Always read the label before opening pesticide containers and follow all precautions and directions.
2. Never smoke, chew tobacco, or eat while handling or applying pesticides. DO NOT carry such items in clothes used for spraying.
3. Always wear neoprene gloves to handle the concentrate, and when coming in contact with dilute spray i.e. cleaning nozzles, and pumps, and handling contaminated spray equipment.
4. Inhalation of spray droplets, dust or fumes should be avoided. Wear a respirator to reduce pesticide inhalation especially when handling dusty formulations or volatile concentrates. For gases, a self-contained breathing apparatus may be required.
5. Wear freshly laundered clothes each day, including caps. Regularly wash gloves and boots. Avoid spilling pesticides on skin or clothing.
6. Avoid contamination of water supplies, wells, ponds, streams, etc. with pesticides when filling or flushing out spray equipment. Never fill a sprayer directly from a stream, pond or well, unless the unit is equipped with an anti-backflow device to prevent siphoning.
7. Keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident. You can use this book, see Table 88 and 89.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including underclothes immediately, and wash contaminated skin thoroughly with soap and water. Wash all clothing including caps, gloves and boots before reuse.
2. If clothing becomes wet with a pesticide, when spraying, remove it immediately. When the spray operation is complete, remove all contaminated clothes, including underclothes, have a bath or shower and put on freshly laundered clothing.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common name chemicals with you to the hospital (See Emergency Procedures for Pesticide Poisoning).
4. Clean up any pesticide spills immediately. Use dry soil or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the Pesticide Control Service for advice (See list page 75).
5. If a well becomes contaminated, follow clean-up instructions in OMAF Factsheet, *Pesticide Contamination of Farm Water Supplies*, Agdex 607.

FIRST-AID INFORMATION

The Occupational Health and Safety Division, Ministry of Labour, 400 University Ave., Toronto, M7A 1T7, has physicians available for consultation on first-aid information and advice. They can be contacted:

Between the hours of 8:00 a.m. and 5:00 p.m. Monday to Friday, telephone (416) 965-3610.

During weekends, public holidays and non-office hours, telephone (416) 965-1211 and ask for the "on-call" physician.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING

If a pesticide is spilled onto clothing or parts of the body remove clothing including under-garments and wash skin and hair with water or soap and water if available. Flush eyes with plenty of water.

Should a person exhibit symptoms of poisoning such as weakness, slow heartbeat, incoordination, tremors, abdominal cramps, salivation, or blurred vision but is still conscious, seek medical help immediately by rushing the patient to the emergency ward of the nearest hospital. If the patient is unconscious call an ambulance.

Always know the common name of the chemical being use. Get this from the label or from the list mentioned above or use this book for reference.

RELATIVE HAZARDS TO MAN FROM INSECTICIDES

Extreme Hazard

Counter (terbufos)
Dasanit (fensulfothion)
Di-Syston (disulfoton)
Dyfonate (fonofos)
Furadan (carbofuran)
Guthion (azinphos-methyl)
Lannate (methomyl)
Thimet (phorate)

These pesticides are dangerous through inhalation, skin contact, or if taken by mouth. A few grams can be fatal. Wear protective clothing (see Precautions with Pesticides), avoid mixing in windy areas, dispose of containers properly (see Precautions with Pesticides) and always wash and change clothing immediately after use.

Moderate Hazard

Ambush (permethrin)
Basudin (diazinon)
Captan* (captan)
Cygon (dimethoate)
Cymbush (cypermethrin)
Decis (deltamethrin)
Imidan (phosmet)
Lorsban (chlorpyrifos)
Ripcord (cypermethrin)
Thiodan (endosulfan)

These pesticides are dangerous if handled carelessly. Caution is required to ensure that they are not taken internally or allowed to contact bare skin. Wear protective clothing including respirator and goggles when mixing or working with them. Avoid breathing the vapors. Wash and remove clothing after applying these materials. Triple rinse and dispose of containers properly (see Precautions with Pesticides).

*Current studies indicate that captan requires special handling procedures as outlined on the label. Therefore follow directions closely.

Low Hazard

Pesticides listed in this publication and not appearing on this list have lower toxicities and should be handled with all precautions listed on the label. Even the most toxic pesticides can be used safely by following all directions and precautions for proper use as listed on the product label.

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating and depressing the serum and red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms. For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the tests should be commenced prior to using these pesticides and not after applications have commenced because the normal level per individual can vary considerably making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are: Basudin (diazinon), Counter (terbufos), Cygon (dimethoate), Dasanit (fensulfothion), Di-Syston (disulfoton), Dyfonate (fonofos), Furadan (carbofuran), Guthion (azinphos-methyl), Imidan (phosmet), Lannate (methomyl), Lorsban (chlorpyrifos), and Thimet (phorate).

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. It is recommended that neoprene or rubber gloves, rubber boots, a protective apron or coveralls, and protective eyeshields be worn to reduce the risk of dermal exposure when measuring, mixing and loading pesticides.

   Protective clothing, including disposable gloves, aprons or coveralls and hat covers, are available at reasonable prices from the major safety supply companies listed below.
2. Wash all clothing after use. Wear freshly laundered clothes each day.
3. Although recommended when loading and handling concentrates, the wearing of dual cartridge chemical respirators is neither mandatory nor required with all pesticides or under all conditions of pesticide use. If a label specifies respiratory protection, follow the directions closely. A wide range of respiratory devices for outdoor respiratory protection from certain pesticides is available from the major safety supply companies who offer both full and half-face models in varying sizes. Consult the safety supply company of your choice for appropriate guidance and selection.

Table 85. Safety Supply Companies in Ontario Providing Protective Clothing and/or Respiratory Devices for Outdoor Protection Against Certain Pesticides.

Respiratory Devices Manufactured By	Available From
American Optical	AOCO Limited, Subsidiary of American Optical Corporation, 60 Mobile Drive, Toronto, M4A 2R7, Tel (416) 752-8780 Branches: Hamilton & Belleville
H.S. Cover (York)	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9, Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Kasco Helmets	The St. George Co., St. George, N0E 1N0. Tel. (519) 442-2046
Mine Safety Appliances	MSA Canada Inc., 148 Norfinch Drive, North York, M3N 1X8, Tel. (416) 667-9400
3M Occupational Health & Safety Products Div.	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill, Ontario, L4B 1E7 Tel. (416) 222-4111 (416) 222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor.
North	Siebe-North Inc., 26 Dansk Court, Rexdale, M9W 5V8, Tel. (416) 675-2790
Racal Airstream	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill, Ontario, L4B 1E7 Tel. (416) 222-4111 (416) 222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor.
Safety House	Safety House of Canada Ltd., 127 Castlefield Ave., Toronto, M6B 1G4, Tel. (416) 789-0631 Branches: Kitchener, London, Orillia, Ottawa, St. Catharines & Stoney Creek.

Scott	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill, Ontario L4B 1E7, Tel. (416) 222-4111 (416) 222- 2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor.
Survivair	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9, Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Willson	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill, Ontario L4B 1E7, Tel. 416-222-4111 416-222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor.

Many of the companies listed above have dealer outlets in addition to branch outlets. For details of dealer outlets contact the supply company of your choice.

REENTRY INTO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The pesticides listed below are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g. parathion, the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum intervals are recommended.

24 Hours	**48 Hours**
Lannate (Methomyl)	Guthion (Azinphos-methyl) Furadan (Carbofuran)

STORAGE

1. **General Storage:**

   The Ontario Pesticides Act and Regulation 751 requires that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.

   Special Storage:

   Schedule 1, 2 and 5-pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words "CHEMICAL STORAGE WARNING — AUTHORIZED PERSONNEL ONLY" in black capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.

2. Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers. See also OMAF Factsheet *Farm Storage of Pesticides*, Agdex 607.

DISPOSAL OF PESTICIDE CONTAINERS & CONTAMINATED MATERIAL

1. Containers from pesticide packages and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or public outdoor areas.

2. Un-rinsed containers can contain as much as 3% of the original formulations. If this amount of toxic pesticide is discarded with the drum it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful — why not use that 3% to control the pest!

   Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic drum, and to rinse the residual left in the container directly into the spray tank. This procedure takes less than a minute and results in a rinsed container. The rinsed containers should be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

SPRAYERS

Herbicide sprayers, capable of delivering sufficient litres per hectare for adequate coverage, are satisfactory for applying emulsion-type insecticides. However, if 2,4-D or related herbicides have been used in them, such sprayers will have to be cleaned thoroughly or foliage is apt to be damaged. The detergent recommended should contain ammonia for best results.

For applying the wettable powder formulations, a high-capacity (450 L/ha), high-pressure piston pump sprayer with an agitator, is recommended. Keep in mind that the higher the pressure the greater the danger of drift to other crops.

Calibrate your sprayer at least twice during the growing season. The wear on nozzles and other parts will alter the amount of spray delivered at the usual speed and pressure.

For information on calibration, see the current OMAF Publication 75, *Guide to Chemical Weed Control*.

APPLICATION BY AIRPLANES OR HELICOPTERS

Aerial applicators must be licensed by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of The Pesticides Act for the application of Schedule 1 and 5 pesticides, and Schedule 2 hormone-type herbicides. The area will be inspected by ministry personnel to ensure safety of application.

It is an offense under the Federal Pest Control Product Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees, e.g. Sevin (carbaryl).

Applications should not be made if the wind is blowing. Some drift occurs even on the stillest day and to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the product to be used is specified, along with rate of application, in the contract.

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby, or reduce the amount of material in the target area as to be ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by paying attention to:

1. correct calibration and maintenance of spray equipment;
2. correct operation of the equipment;
3. being aware of the toxicity of the pesticide in use; and
4. being aware of the weather conditions.

For more information consult OMAF Factsheet, *Pesticide Drift*, Agdex 607, or Canadex 607, *Pesticides: Effects of Drift and Droplet Size*.

PROTECT HONEYBEES

Honeybees as well as other bees and insects are important pollinators of several field crops including alfalfa, canola, clover, and trefoil. These pollinators are critical to maximizing seed production. Some crops such as Canola, and legumes are important sources of honey, while these crops and corn are important pollen sources for bees.

Insecticides, many of which kill bees, are required for insect control. With careful management, you can obtain good insect control without killing bees. You can protect bees by following these suggestions:

1. Do not apply insecticides while crops are in bloom
2. Time of treatment is important. In general, daytime treatments, when bees are foraging in the field, are most hazardous. Insecticides applied in the very early morning or evenings are safest.
3. If there is a risk of honeybees poisoning, try to choose an insecticide that is not highly toxic to the bees (use the pesticide rating that follows).

WHEN PLANNING TO APPLY A PESTICIDE, ADVISE LOCAL BEEKEEPERS SO THEY HAVE AN OPPORTUNITY TO MOVE COLONIES OUT OF THE DANGER AREA. YOUR LOCAL AGRICULTURAL REPRESENTATIVE HAS A LISTING OF THE BEEKEEPERS IN YOUR AREA.

Table 86. Pesticide Toxicity to Bees

Extremely Toxic

Sevin
Furadan

These insecticides have caused more loss (confirmed cases of poisoning) to bees than any of the other materials listed below. Growers and apiarists require close liaison where these materials are used.

Highly toxic

Ambush
Cygon
Cymbush
Decis
diazinon
Guthion
Imidan
Lorsban
malathion
Ripcord

Severe losses may be expected if these materials are used when bees are present at treatment time or within a few days thereafter.

Moderately Toxic

Dylox
Lannate
Thiodan

These can be used around bees if dosages, timing, and methods of application are correct, but should not be applied directly on bees, in the field or at the colonies.

Relatively Non-Toxic

methoxychlor
All the fungicides

SEED TREATMENTS

Seed dressings or treatments are poisonous to man and livestock. Do not inhale the fumes or dust when treating or handling treated seed. Wash all residues of these chemicals from the skin after seed treatment is completed. Chemically treated seed is poisonous. Never feed surplus seed to livestock. Destroy all bags that have held treated seed as recommended in the container disposal section above.

RESIDUES ON CROPS TO BE HARVESTED, FED OR GRAZED

Certain pesticide residues disappear quickly after application; others persist in poisonous form for much longer periods. When crops with persistent residues are fed to livestock the poisons tend to accumulate in the body fat and milking cows will excrete them, or their metabolic products in the milk. Young calves, heifers, and dry cows will store these in body fat and secrete them when they freshen months later. Do not use residues from Thiodan-treated crops for bedding. To avoid residue problems, use (1) the proper chemical, (2) the recommended dosage, and (3) observe the proper interval to harvest.

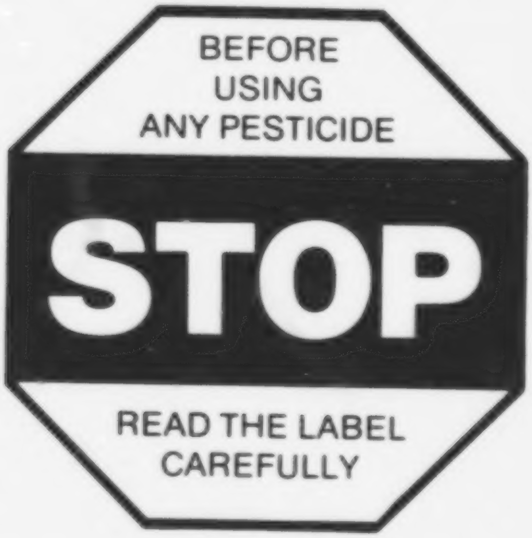
FORMULATIONS

Pesticides may be in either liquid or solid form.

Liquids	E or EC	— Emulsifiable Concentrate
	F	— Flowable
	L	— Liquid
	LC	— Liquid Concentrate
	S	— Sprayable
	SC	— Sprayable Concentrate
	Su	— Suspension
Solids	G	— Granular
	P	— Powder
	SP	— Soluble Powder
	WP	— Wettable Powder
	W	— Wettable

Table 87. The Addresses and Phone Numbers of Companies Supplying Insecticides

Distributor	Address	Phone
Agrospray	P.O. Box 130, 40 Cedar St. Tillsonburg, Ont. N4G 4H3	(519) 842-8408
Bartlett	P.O. Box 490, 931 Bartlett Rd. Beamsville, Ont. L0R 1B0	(416) 563-8261
Chipman	P.O. Box 9910 Stoney Creek, Ont. L8G 3Z1	(416)643-4123
Ciba-Geigy	6860 Century Ave. Mississauga, Ont. L5N 2W5	(416) 821-4420
King Agro Inc.	P.O. Box 1088, Chatham, Ont. N7M 5L6	(519) 354-3210
Niagara	1274 Plains Rd. E., Burlington, Ont. L7S 1W6	(416) 634-2355
Pfizer	1 Wilton Grove Rd., P.O. Box 2005, London, Ont. N6A 4C6	(519) 681-2173
Sanex	2695 Slough St. Mississauga, Ont. L4T 1G2	(416) 677-4820
UCO	P.O. Box 527, Station A Mississauga, Ont. L5A 3A1	(416) 270-3560



Handy Metrics Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre.

Table 88. Fungicides For Field Crops

Trade Name	Active Ingredient	Formulation[1]	Ontario Schedule[2]
SEED TREATMENTS			
Fungicides			
Agrox N-M	maneb	P-DB	3
Agrox flowable	maneb	S	3
Anchor	carbathiin + thiram	S	2
Busan 30	TCMTB	EC	2
Captan Flowable	captan	S	2
Captan 30	captan	S	2
Co-op N M	maneb	P-DB	3
Vitaflo-250	carbathiin	S	3
Vitaflo-280	carbathiin + thiram	S	3
Vitavax Powder	carbathiin + thiram	P-DB	2
Fungicides with Insecticides			
Agrox B-3	diazinon + lindane + captan	P-DB	2
Agrox D-L Plus	diazinon + lindane + captan	P-DB	2
Co-op D-L + C	diazinon + lindane + captan	P-DB	2
Captan 30-Methoxychlor 3	captan + methoxychlor	S	2
Co-op N M Dual Purpose	maneb + lindane	P-DB	3
DCT	diazinon + captan + thiophanate-methyl	P-DB	3
Drillbox D-L + C	diazinon + lindane + captan	P-DB	2
Drillbox Lindasan	captan + lindane	P-DB	2
Gammasan +	captan + lindane	S	2
Mergamma N-M	maneb + lindane	P-DB	2
Methoxychlor 3 (flowable)	captan + methoxychlor	S	2
Polyram-Diazinon	diazinon + metiram	P	3
Vitaflo Dual Purpose	carbathiin + thiram + lindane	S	2
Vitavax Dual Powder	carbathiin + thiram + lindane	P-DB	2
Vitavax RS Flowable	carbathiin + thiram + lindane	P-DB	3
FOLIAR SPRAYS — Fungicides			
Bayleton	triadimefon	WP	1
Benlate 50 W	benomyl	WP	3
Botran 75 W	dichloran	WP	3
Dithane M45	mancozeb	WP	3
Easout 70 W	thiophanate-methyl	WP	3
Rovral 50 W	iprodione	WP	3

[1] EC (Emulsifiable Concentrate); P-DB (Powder Drill Box); S (Flowable Suspension); WP (Wettable Powder).

[2] The numbers identify the Schedules in which the TRADE NAME products listed in this Table are classified under the Pesticides Act.

Explanation of Schedules.

Schedule 1	Restricted. Use permit only.
Schedule 2	Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3	May be available for "Domestic" purposes if so registered.
Schedule 4	"Domestic" products only.
Schedule 5	Limited to application on agricultural land.
Schedule 6	Similar to schedule 4 but may be registered for agricultural / commercial use.

For further information on the regulatory aspects of the classification please contact the Ministry of the Environment office nearest you.

Table 89. Insecticide Notes

Trade Name & Formulation (active ingredient)	Insecticide Classification	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[2]
Ambush 500 EC (permethrin)	pyrethroid	Not after 5 leaf stage	Moderately toxic	No	Chipman UCO	Corn	(3)
Basudin 50 W (diazinon)	organo phosphorus	14	Moderately toxic	Yes	Chipman Niagara Pfizer Sanex	Alfalfa, corn, field beans, peas. Toxic to bees.	(2)
Counter 15 G (terbufos)	organo phosphorus	planting time only	Extremely toxic	No	Pfizer	Corn	(5)
Cygon 480 E (dimethoate)	organo phosphorus	2 Alfalfa 7 Beans	Moderately toxic	Yes	Bartlett Chipman Niagara Pfizer, UCO Sanex	Alfalfa, field beans. Toxic to bees.	(2)
Cymbush 250 EC (cypermethrin)	pyrethroid	30	Moderately toxic	No	Chipman	Corn, canola	(2)
Dasanit 15 G (fensulfothion)	organo phosphorus	planting time	Extremely toxic	No	Niagara Pfizer, UCO	Corn	(2)
Decis 2.5 EC (deltamethrin)	pyrethroid	14	Moderately toxic	No	Pfizer Niagara	Canola	(2)
Diazinon 50 W (diazinon)	organo phosphorus	14	Moderately toxic	Yes	Ciba-Geigy	grasshoppers	(2)
Dipel SC *(Bacillus-thuringiensis)*	Bacterial toxin	0	Lower toxicity	Yes	Niagara	Timothy	(3)
Di-Syston 15 G, 720 LC (disulfoton)	organo phosphorus	planting time only	Extremely toxic	No	Niagara Pfizer	Corn	(5)
Dyfonate 20 G (fonofos)	organo phosphorus	planting time only	Extremely toxic	No	Chipman UCO	Corn	(5)
Dylox 80% SP, 420 Liquid (trichlorfon)	organo phosphorus	21	Lower toxicity	Yes	Agrospray Niagara UCO	Cereals. Relatively safe to bees.	(3)
Furadan 10 G, CR-10 G, 480 F (carbofuran)	carbamate	planting time only 7	Extremely toxic	Yes Permit Required	Bartlett King Agro Niagara UCO	Corn, Alfalfa. Toxic to bees.	(2), (Granular). (5), (Flowable).
Guthion 240 SC (azinphos-methyl)	organo phosphorus	3 Beans 21 Alfalfa 30 Grain	Extremely toxic	Yes, Permit Required	Bartlett Niagara Pfizer	Field beans, soybeans. Toxic to bees.	(5)
Imidan 50 W (phosmet)	organo phosphorus	7	Moderately toxic	Yes	Chipman	Alfalfa. Toxic to bees.	(3)
Lannate L (methomyl)	carbamate	21	Extremely toxic	Yes	Pfizer Niagara	Grain	(2)
Lorsban 4 E, 15 G (chlorpyrifos)	organo phosphorus	70	Moderately toxic	Yes Permit Required	Pfizer King Agro	Corn, canola, cereals	(3)

Table 89. Insecticide Notes (Cont'd)

Trade Name & Formulation (active ingredient)	Insecticide Classification	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[2]
Malathion 500 EC, 25 W (malathion)	organo phosphorus	7	Lower toxicity	Yes	Bartlett Chipman Niagara Pfizer Sanex UCO	Alfalfa, grain crops, field beans soybeans. Toxic to bees. Less effective below 16°C	(3)
Methoxychlor 240 EC, 50 W (methoxychlor)	organo chlorine	7	Lower toxicity	Yes	Bartlett Chipman Niagara Sanex UCO	Alfalfa, grain crops. Relatively safe to bees.	(3)
Ripcord 400 EC (cypermethrin)	pyrethroid	30	Moderately toxic	No	Ciba-Geigy	Canola Corn	(2)
Sevin 480 Su (carbaryl)	carbamate	1 Corn 3 Peas 14 Grain 1 Alfalfa 1 Beans	Lower toxicity	Yes	Bartlett Chipman Niagara Pfizer UCO	Alfalfa, corn, field beans, soybeans, grain crops. Extremely toxic to bees.	(3)
Thimet 15 G (phorate)	organo phosphorus	planting time only	Extremely toxic	No	Pfizer UCO	Corn	(2)
Thiodan 4 EC (endosulfan)	organo chlorine	2	Moderately toxic	Yes	Chipman Niagara Pfizer Sanex	Field beans, soybeans. Toxic to bees.	(2)
Thuricide HPC *(Bacillus-thuringiensis)*	Bacterial toxin	0	Lower toxicity	Yes	Chipman	Timothy	(3)

[1] *See Pesticides Section, Relative Hazards to Man from Insecticides*

[2] The numbers within the brackets ( ) identify the Schedules in which the TRADE NAME products listed in this Table are classified under the Pesticides Act.

Explanation of Schedules.

Schedule 1	Restricted. Use permit only.
Schecule 2	Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3	May be available for "Domestic" purposes if so registered.
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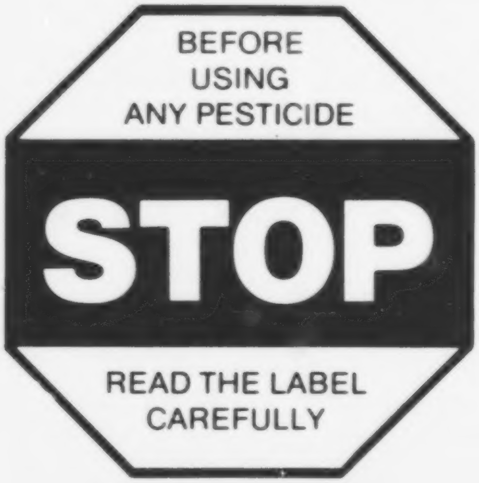

GENERAL INFORMATION

SEEDING INFORMATION

Crop	Seeding Rate kg/ha	Seed Weight	
		kg/hl	lb/bu
Wheat (Winter & Spring)	100-130	75	60
Oats (not seeded down)	55-110	42	34
(seeded down)	40-55	-	-
Barley (Winter & Spring)	80-160	60	48
Rye (small seeded varieties)	70-95	70	56
(large seeded varieties)	120-160	-	-
Triticale (OAC Wintri)	75-100	65	52
Corn (Field)	11-22	70	56
White Beans (70 cm rows)	40-45	75	60
Soybeans	65-155	75	60
Peas (Field)	130-200	75	60
Buckwheat	55	60	48
Flax	40	70	56
Canola (Spring & Winter)	4-5	62	50
Millet (Proso)	45	70	56
Sunflower	6-8	30	24
Mustard (Yellow)	8-11	62	50
Sorghum-sudan grass, sudan grass, forage sorghum	14	50	40

SEEDS PER UNIT OF FORAGE SPECIES

Crop	Seeds per kg
Alfalfa	440,000
Red Clover	605,000
White Clover	1,760,000
Bird's-foot Trefoil	935,000
Sweet Clover	572,000
Alsike	1,540,000
Timothy	2,706,000
Orchard Grass	1,439,000
Bromegrass	300,000
Meadow & Tall Fescue	506,000
Perennial Rye Grass	500,000
Reed Canary Grass	1,173,000
Bluegrass	4,790,000

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

County	OMAF Offices		Field Crops Specialists	
Essex	46 Fox St., Essex N8M 2S2	519-776-7361	Henry Olechowski c/o RCAT, Ridgetown N0P 2C0	519-674-5456
Kent	Box 726, 435 Grand Ave. W. Chatham N7M 5L1	519-354-2150		
Lambton	Box 730, Petrolia N0N 1R0	519-882-0180	Peter Johnson 367 Ridout St., London N6A 2P2	519-434-6811
Middlesex	50 King St., London N6A 2P2	519-434-6811		
Oxford	Box 666, Woodstock N4S 7Z5	519-537-6621	Hugh Martin 594 Talbot St., St. Thomas N5P 1C7	519-631-4700
Elgin	594 Talbot St., St. Thomas N5P 1C7	519-631-4700		
Norfolk	Box 587, Simcoe N3Y 4N5	519-426-7120	Henriette Plas Box 587, Simcoe N3Y 4N5	519-426-7120
Brant	207 Greenwich St., Brantford N3S 2X7	519-759-4190		
Haldimand	Box 129, Cayuga N0A 1E0	416-772-3381		
Huron	Box 159, Clinton N0M 1L0	519-482-3428	John Heard Box 398 413 Hibernia St., Stratford N5A 6T3	519-271-0280
Perth	Box 398, 413 Hibernia St. Stratford N5A 6T3	519-271-0280		
Wentworth	R.R. 1, Ancaster L9G 3K9	416-527-2995	Jerry Winnicki 574 South Pelham St., Welland, L3C 3C6	416-732-7552
Niagara, North	Vineland Station L0R 2E0	416-562-4142		
Niagara, South	574 South Pelham St., Welland L3C 3C6	416-732-7552		
Wellington	R.R.1, Fergus N1M 2W3	519-846-0941	Harvey Wright c/o Crop Science University of Guelph, Guelph N1G 2W1	519-824-4120 Ext. 6763
Waterloo	279 Weber St. N., Waterloo N2J 3H8	519-884-5390		
Halton	17 Wilson Dr., Milton L9T 3J7	416-878-2314		
Bruce	Box 1330, Walkerton N0G 2V0	519-881-3301	Joan McKinlay 181 Toronto St. S. Markdale, N0C 1H0	519-986-2040
Grey	181 Toronto St. S., Markdale N0C 1H0	519-986-2040		
Dufferin	R.R. 4, Orangeville L9W 2Z1	519-941-3830		
Simcoe, North	Box 340, Elmvale L0L 1P0	705-322-2231	Dave Morris Box 370, Alliston L0M 1A0	705-435-5521
Simcoe, South	Box 370, Alliston L0M 1A0	705-435-5521		
Peel	35 Van Kirk Dr., Unit 9 Brampton L7A 1A5	416-451-5474		
York	Newmarket Plaza, Newmarket L3Y 1N1	416-895-4519		
Durham West	Box 309, Uxbridge L0C 1K0	416-852-3328	Jack Kyle 322 Kent St. W., Lindsay K9V 2Z9	705-324-6125
Victoria - Haliburton	322 Kent St. W., Lindsay K9V 2Z9	705-324-6125		
Durham East	234 King St. E., Bowmanville L1C 1P5	416-623-3348		
Peterborough	55 George St. N. Peterborough K9J 3G2	705-745-2403		

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

County	OMAF Offices		Field Crops Specialists	
Northumberland	Box 820, Brighton K0K 1H0	613-475-1630	John Nederend Box 470, Picton K0K 2T0	613-476-3224
Hastings	Box 340, Stirling K0K 3E0	613-395-3393		
Lennox & Addington	41 Dundas St. W., Napanee K7R 1Z5	613-354-3371		
Prince Edward	Box 470, Picton K0K 2T0	613-476-3224		
Frontenac	Box 651, 1055 Princess St. Kingston K7L 4X1	613-545-4360		
Leeds	Box 635, Brockville K6V 5V8	613-342-2124	Gilles Quesnel Box 2004, Kemptville K0G 1J0	613-258-8304
Grenville	Box 2004, Kemptville K0G 1J0	613-258-8298		
Dundas	Box 488, Winchester K0C 2K0	613-744-2313		
Stormont	Box 97, Avonmore, K0C 1C0	613-346-2143		
Lanark	P.O. Box 37, Perth K7H 3E2	613-267-1063	Dorothy Haley 26 Thorncliff Place Nepean K2H 6L2	613-828-9167
Renfrew	315 Raglan St. S., Renfrew K7V 1R6	613-432-4841		
Carleton	26 Thorncliff Place, Nepean K2H 6L2	613-828-9167		
Prescott	Box 110, Plantagenet K0B 1L0	613-673-5115	Paul Beaudin Box 110 Plantagenet K0B 1L0	613-673-5115
Russell	Box 540, 666 Notre Dame St. Embrun K0A 1W0	613-443-3391		
Glengarry	Box 579, Alexandria K0C 1A0	613-525-1046		

Northern Ontario District Offices

District	OMAF Offices		Field Crops Specialists	
Algoma	1496 Wellington St. E. Sault Ste. Marie P6A 2R1	705-253-1161	Stephen Clare 222 McIntyre St. W. North Bay P1B 2Y8	705-474-3050
Cochrane, N.	Experimental Farm Kapuskasing P5N 2X9	705-335-5828		
Cochrane, S	Box 608, Matheson P0K 1N0	705-273-2509		
Kenora	Ontario Government Building Box 3000, Dryden P8N 3B3	807-223-2415		
Manitoulin	Box 328, Gore Bay P0P 1H0	705-282-2043		
Muskoka & Parry Sound	Box 130, Huntsville P0A 1K0	705-789-8886		
Nipissing	222 McIntyre St. W., North Bay P1B 2Y8	705-474-3050		
Rainy River	Front St., Emo P0W 1E0	807-482-2310		
Sudbury	1899 LaSalle Blvd., Sudbury P3A 2A3	705-566-1630		
Timiskaming	Box "G," New Liskeard P0J 1P0	705-647-6701		
Thunder Bay	Ontario Government Building 435 James St. S. Thunder Bay P7E 6E3	807-475-1631		

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Tobacco Specialists

Milt Watson, Norm Sheidow	Research Station, Box 186, Delhi, N4B 2W9 519-582-1950

Pasture Specialist

Susan Robinson	222 McIntyre St. W. North Bay, P1B 2Y8	705-474-3050

Insect and Disease Specialists

Insects	Karl Bereza, R.R. 1, Ancaster L9G 3K9	416-527-2995
Diseases	Craig Hunter, Research Station, P.O. Box 587, Simcoe N3Y 4N5	519-426-7120
Insects & Diseases	Tom Hartman, c/o Crop Science, University of Guelph, Guelph N1G 2W1	519-824-4120, Ext. 3410

DISTRIBUTORS OF VARIETIES RECOMMENDED IN PUBLICATION 296

Aishling Farm Seeds RR#2, Baltimore K0K 1C0	416-372-5359
Bishop Farm Seeds Ltd. Box 338, Belleville, Ontario K8N 5A5	613-968-5533
C & M Seeds RR#3, Palmerston, Ontario N0G 2P0	519-343-2126
Dekalb Canada Inc. Box 430, Chatham, Ontario N7M 5K5	519-352-5310
Funk Seeds Box 29, Hyde Park, Ontario N0M 1Z0	519-473-2651
General Seed Co. Box 5021, Hamilton, Ontario L8S 4K9	416-648-6900
Jacques Canada Ltd. Box 100, Emeryville, Ontario N0R 1C0	519-727-6046
King Agro Inc. P.O. Box 1088, Chatham, Ontario N7M 5L6	519-354-3210
Labonté Seeds Ltd. Box 1660, New Liskeard, Ontario P0J 1P0	705-647-6821
Maple Leaf Mills Limited P.O. Box 9, Wallaceburg, Ontario N8A 4L5	519-627-1428
Mapleseed Inc. Oakwood, Ontario K0M 2M0	705-786-2020
Northrup Kings Seeds Ltd. 1250 Franklin Blvd., Box 1207 Cambridge, Ontario N1R 6C9	519-621-0890
Oseco Inc. P.O. Box 219, Brampton, Ontario L6V 2L2	416-846-5080
Oseco Farm Seed Centre 75 Cardigan Street, Guelph, Ont. N1H 3Z7	519-822-4800
Otto Pick & Sons Seeds Ltd. Box 126, Richmond Hill, Ontario L4C 4X9	416-884-1147
PAG Seeds Box 490, Princeton, Ontario N0J 1V0	519-458-4336
Pioneer Hi-Bred Ltd. Box 730, Chatham, Ontario N7M 5L1	519-352-6350
Rothwell Seeds Ltd. Box 511, Lindsay, Ontario K9V 4L9	705-324-9591
SeCan Association* Suite 512, 885 Meadowlands Dr. Ottawa, Ontario K2C 3N2	613-225-6891
Speare Seeds Ltd. P.O. Box 171, Harriston, Ontario N0G 1Z0	519-338-3840
Tib Szego Associates Ltd. P.O. Box 366, Lindsay, Ontario K9V 4S3	705-324-0042
United Cooperatives of Ontario 151 City Centre Drive Mississauga, Ontario L5A 3A4	416-270-3560
W.G. Thompson & Sons Ltd. Box 250, Blenheim, Ontario N0P 1A0	519-676-5411

**SeCan is an association of seed growers and seed companies which handles the release and promotion of publicly developed varieties. For more information on these varieties, contact your local SeCan member.*

ONTARIO MINISTRY OF THE ENVIRONMENT — PESTICIDES CONTROL FIELD OFFICES

Counties	Field Offices	Telephone
Southwestern Region		
Elgin, Middlesex, Oxford	985 Adelaide Street South, London N6E 1V3	519-661-2200
Essex, Kent, Lambton	P.O. Box 726, 435 Grand Ave. W. Chatham N7M 5L1	519-354-2150
Bruce Grey, Huron, Perth	20 King Street, P.O. Box 688, Ont. Ministry of Agr. & Food Bldg. Clinton N0M 1L0	519-482-3428
West Central Region		
Haldimand, Norfolk, Niagara, Hamilton, Wentworth Dufferin, Wellington, Waterloo, Brant	Ont. Gov't Bldg. 119 King St. W. Hamilton L8N 3Z9	416-521-7640
Central Region		
Halton, Peel, York, Durham, Toronto, Simcoe, Muskoka	7 Overlea Blvd., Don Mills M4H 1A8	416-424-3000 (ext. 211)
Peterborough, Victoria, Haliburton, Northumberland	139 George Street N., Peterborough K9J 3G6	705-743-2972
Southeastern Region		
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	133 Dalton St., P.O. Box 820 Kingston K7L 4X6	613-549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	2378 Holly Lane, Suite 204, Ottawa K1V 7P1	613-521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury, Cochrane, Timiskaming, Algoma	199 Larch St., Sudbury P3E 5P9	705-675-4501
Northwestern Region		
Kenora, Rainy River, Thunder Bay	Ontario Government Building, 435 James St. S., Thunder Bay P7C 5G6	807-475-1215
Head Office		
Agricultural and Industrial Chemicals Section	135 St. Clair Avenue W., Suite 100 Toronto M4V 1M2	416-323-5095
Pesticide Licencing & Examination Section	Environmental Approvals Branch 135 St. Clair Avenue West Suite 1101, Toronto M4V 1P5	416-323-4444

PUBLICATIONS — The following publications are available from any of the Pesticide Control Field offices or from the Head Office of the Ministry of the Environment

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical-Storage Signs

PUBLICATIONS

Available from your local office of the Ontario Ministry of Agriculture and Food

CORN

Corn Production in Ontario — Publication 13
1987 Ontario Hybrid Corn Performance Trials Report

Factsheets:

111/25	*Corn Lodging*
111/31	*Heat Units for Corn in Southern Ontario*
111/61	*High Moisture Corn*
100/531	*Zinc Requirements for Field Crops*
111/541	*Nitrogen Recommendations for Corn*
111/542	*Nitrogen Fertilizer Materials*
111/622	*European Corn Borer*
111/622	*Corn Leaf Aphid*
111/622	*Corn Rootworms*
111/622	*Potato Stem Borer in Field Corn*
111/630	*Stunting of Young Corn*
111/632	*Heat Smut of Corn*
111/632	*Leaf Diseases of Field Corn*
111/736	*Harvesting and Storing Quality Grain Corn*
111/742	*Calibrating Your Corn Planter*
111/745	*Measuring Corn Harvesting Losses*
111/840	*Pricing Corn in Ontario*
440/60	*Moldy Feeds and Swine Diseases*
610	*Slugs*
675	*Sap Beetles on Raspberries, Tomatoes, Corn*

FORAGES

Alfalfa — Publication 59
Pasture Production — Publication 19
Quality Forage for Milk or Beef — Publication 54
Annuals for Supplementary Feed — Publication 47
Red Clover for Feed, Seed and Soil — Publication 221

Factsheets:

120/22	*Successful Forage Establishment*
120/31	*Selecting a Perennial Forage*
120/52	*Quality Hay Crop Silage*
120/81	*Protein Supplements from Forage Legumes*
120/30	*Fertilizer Use in Forage Establishment*
120/622	*European Skipper*
120/736	*Barn Hay Drying*
120/745	*Haying with a Large Round Baler*
122/21	*Alfalfa Persistence*
121/21	*Establishment of Bird's-Foot Trefoil*
121/21	*Stop Alfalfa Winterkill*
121/531	*Boron Requirements for Alfalfa*
121/542	*Fertilizer Practices for Alfalfa Production*
121/600	*Verticillium Wilt of Alfalfa*
121/622	*Alfalfa Weevil*
121/622	*Early Warning System for Alfalfa Weevil Management*
121/622	*Alfalfa Blotch Leafminer*
121/622	*Potato Leafhopper in Alfalfa*
121/736	*Determining Moisture Content of Alfalfa Using a Microwave Oven*
122	*Producing Red Clover Seed in Ontario*
122/10	*Red Clover in Ontario*
122/20	*Bird's-Foot Trefoil Production*
122/22	*Establishment of Bird's-Foot Trefoil*
136	*Birdsfoot Trefoil Seed Production*
460/10	*Hay and Pasture for Horses*

CEREAL GRAINS

Rid Ontario of Common Barberry and European Buckthorn — Publication 49
Insects in Farm Stored Grain — Publication 229
Smut Diseases of Grain Crops — Publication 524
1986 Regional Test Report Barley, Oats, and Wheat, Department of Crop Science, University of Guelph

Factsheets:

100/531	*Manganese In Soybean and Small Grain Production*
110/622	*Armyworms*
110/632	*Cereal Virus Diseases*
110/717	*Grain Aeration*
112/10	*Winter Wheat in Ontario*
112/630	*Root, Crown and Basel Stem Diseases of Winter Wheat*
112/630	*Head Diseases of Winter Wheat*
112/600	*Leaf Diseases of Winter Wheat*
113/632	*Oat-Cyst Nematode*
114/542	*Fertilizing Practices for Growing Barley*
114/632	*Leaf and Head Diseases of Barley*
118/10	*Winter Triticale In Ontario*

FIELD BEANS

Factsheets:

140/630	*Virus Diseases and Bronzing of Field and Snap Beans*
142	*Growing White Beans in Ontario*
142/10	*Kidney Beans in Ontario*
142/622	*White Bean Insects*
142/632	*Common Blight of Field Beans*
255/630	*Fungal Diseases of Field and Snap Beans*

FIELD PEAS

Factsheets:

142/13	*Field (Dry) Peas in Ontario*

SOYBEANS

Soybean Production in Ontario — Publication 173
1987 Report, Ontario Soybean Variety Trials

Factsheets:

100/531	*Manganese in Soybean and Small Grain Production*
141/10	*Getting into Soybeans — Harvesting, Marketing, Storage and Feeding*
141/10	*Getting into Soybeans — Planting and Growing the Crop*
141/745	*Measuring Soybean Harvesting Losses*
141/840	*Pricing and Marketing Soybeans*

FLAX

148/10	*Flax in Ontario*

CANOLA

149/10	*Spring Canola in Ontario*

HERBICIDES AND WEEDS

Guide to Chemical Weed Control — Publication 75
Ontario Weeds — Publication 505 Price $5.00

Factsheets:

744	*Weed Sprayer Calibration*
100/744	*Calibration of Flood-Jet Nozzles*
607	*Pesticide Drift*
640	*Cocklebur*
640	*The Annual Nightshades*
640	*Proso Millet*
642	*Field Bindweed*
642	*Jerusalem Artichoke*
642	*Pigweeds (Redroot, Green and Smooth)*
641	*Long-Term Weed Control Planning*

SOILS

Ontario Soils — Publication 492
Windbreaks on the Farm — Publication 527

Factsheets:

100/516	*Tillage for Crop Production on Ontario Soils — Practices*
100/536	*Tillage Practices for Residue Management and Erosion Control*
100/516	*Tillage for Crop Production on Ontario Soils — Principles*
100/538	*Manure for Crop Production*
100/540	*Foliar and Liquid Fertilizers*
100/531	*Zinc Requirements for Field Crops*
534	*Soil Acidity and Liming*
542	*Guidelines for Safe Rates of Nutrients Applied at Seeding*
554	*Surface Drainage*
555	*Management of Drained Fields*
540	*Chemical and Organic Fertilizers*
100/541	*How and Where to Use Sewage Sludge in Crop Production*
562	*Irrigation — Water Supply*
573	*Grassed Waterways*
573	*Gulley Erosion Control*
606	*Soil Fumigants*

PESTICIDE USE

Factsheets:

607	*Protective Clothing When Using Pesticides Outdoors*
607	*Farm Storage of Pesticides*
607	*Pesticide Contamination of Farm Water Supplies*
607	*Pesticide Drift*
607	*Pesticide Container Rinsing*

AVAILABLE FROM ONTARIO MINISTRY OF THE ENVIRONMENT FIELD OFFICES

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical Storage Signs

AVAILABLE FROM INFORMATION SERVICES, AGRICULTURE CANADA, OTTAWA K1A 0C7

Growing and Managing Alfalfa in Canada — Publication 1705E
Reed canarygrass: a production guide — Publication 805E
Production of Field Peas in Canada — Publication 1710E
Growing Flax in Canada — Publication 1577E
Common Insects of Corn in Eastern Canada — Publication 945E
Ergot of Grains and Grasses — Publication 1438E
Insects and Mites in Farm-Stored Grain — Publication 1595E
Control of the European corn borer — Publication 1738E
Smut diseases of wheat, barley, oats and rye — Publication 1766E
Farm pasture fencing — Publications 1568E

AVAILABLE FROM CANADIAN SEED GROWERS ASSOCIATION, BOX 8455, OTTAWA, ONTARIO K1G 3T1

Pedigreed Forage Seed Production
Rogues and Roguing Cereal Crops

BEFORE
USING
ANY PESTICIDE
STOP
READ THE LABEL
CAREFULLY

METRIC INFORMATION

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetre (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight-Volume Equivalents (for water)

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001L)

Weight Measures

100 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry—Liquid Equivalents

1 cm^3 = 1mL
1 m^3 = 1000 L

APPROXIMATE APPLICATION RATE CONVERSIONS

Metric to Imperial

litres per hectare x 0.09 = gallons per acre
litres per hectare x 0.36 = quarts per acre
litres per hectare x 0.71 = pints per acre
millilitres per hectare x 0.015 = fluid ounces per acre
grams per hectare x 0.015 = ounces per acre
kilograms per hectare x 0.89 = pounds per acre
tonnes per hectare x 0.45 = tons per acre

Imperial to Metric

gallons per acre x 11.23 = litres per hectare (L/ha)
quarts per acre x 2.8 = litres per hectare (L/ha)
pints per acre x 1.4 = litres per hectare (L/ha)
fluid ounces per acre x 70 = millilitres per hectare (mL/ha)
tons per acre x 2.24 = tonnes per hectare (t/ha)
pounds per acre x 1.12 = kilograms per hectare (kg/ha)
ounces per acre x 70 = grams per hectare (g/ha)

Dry-Weight Equivalents

Grams or Kilograms per Hectare		Approximate Ounces or Pounds per Acre
100 grams	=	1½ ounces
200 grams	=	3 ounces
300 grams	=	4¼ ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1¼ pounds
2.00 kilograms	=	1¾ pounds
2.50 kilograms	=	2¼ pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3½ pounds
5.00 kilograms	=	4½ pounds
6.00 kilograms	=	5¼ pounds
7.50 kilograms	=	6¾ pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11½ pounds
15.00 kilograms	=	13½ pounds

Liquid Equivalents

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

CONVERSION TABLES

METRIC TO IMPERIAL

Length
1 millimetre (mm) = 0.04 inch
1 centimetre (cm) = 0.40 inch
1 metre (m) = 39.40 inches
1 metre (m) = 3.28 feet
1 metre (m) = 1.09 yards
1 kilometre = 0.62 mile

Volume (liquid)
1 millilitre (mL) = 0.035 fluid ounce
1 litre (L) = 1.76 pints
1 litre (L) = 0.88 quart
1 litre (L) = 0.22 gallon (Imperial)
1 litre (L) = 0.26 gallon (U.S.)

Weight
1 gram (g) = 0.035 ounce
1 kilogram (kg) = 2.21 pounds
1 tonne (t) = 1.10 short tons
1 tonne (t) = 2205 pounds

Pressure
1 kilopascal (kPa) = 0.15 pounds/square inch

Area
1 square centimetre (cm^2) = 0.16 square inch
1 square metre (m^2) = 10.77 square feet
1 square metre (m^2) = 1.20 square yards
1 square kilometre (km^2) = 0.39 square mile
1 hectare (ha) = 107,636 square feet
1 hectare (ha) = 2.5 acres

Volume (dry)
1 cubic centimetre (cm^3) = 0.061 cubic inch
1 cubic metre (m^3) = 1.31 cubic yards
1 cubic metre (m^3) = 35.31 cubic feet
1000 cubic metres (m^3) = 0.81 acre-foot
1 hectolitre (hL) = 2.8 bushels

Speed
1 metre per second = 3.28 feet per second
1 metre per second = 2.24 miles per hour
1 kilometre per hour = 0.62 mile per hour

Temperature
°F = (°C x 9/5) + 32
°C = (°F—32) x 5/9

IMPERIAL TO METRIC

Length
inch = 2.54 cm
foot = 0.30 m
yard = 0.91 m
mile = 1.61 km

Area
square foot = 0.09 m^2
square yard = 0.84 m^2
acre = 0.40 ha

Weight
ounce = 28.35 g
pound = 453.6 g
ton = 0.91 tonne

Volume (dry)
cubic yard = 0.76 m^3
bushel = 36.37 L

Volume (liquid)
fluid ounce (Imp.) = 28.41 mL
pint (Imp.) = 0.57 L
gallon (Imp.) = 4.55 L
gallon (U.S.) = 3.79 L

Pressure
pound per square inch = 6.90 kPa

1987 FIELD CROP RECOMMENDATIONS

Information supplied under the direction of the Ontario Field Crops Research Committee, composed of representatives of the following organizations:

- Ontario Agricultural College
  - University of Guelph
- Ontario Ministry of Agriculture and Food
  - Colleges of Agriculture Technology:
    - Centralia
    - Kemptville
    - New Liskeard
    - Ridgetown
  - Agricultural Representatives Branch
  - Plant Industry Branch
- Agriculture Canada
  - Research Station, Harrow
  - Research Station, Ottawa
  - Research Station, London
  - Research Station, Kapuskasing
  - Research Station, Thunder Bay
- Ontario Cereal Crops Committee
- Ontario Corn Committee
- Ontario Crop Protection Committee
- Ontario Field Bean Committee
- Ontario Forage Crops Committee
- Ontario Oil and Protein Seed Crops Committee
- Ontario Soil Management Research Committee
- Ontario Weed Committee

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ALWAYS
A PLACE TO FILL.

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Centralia College of Agricultural Technology, Huron Park, Ontario N0M 1Y0 Telephone: (519) 228-6691

Collège de technologie agricole et alimentaire d'Alfred, Alfred, Ontario K0B 1A0 Telephone: (613) 679-2218

Kemptville College of Agricultural Technology, Kemptville, Ontario K0G 1J0 Telephone: (613) 258-8335

New Liskeard College of Agricultural Technology, New Liskeard, Ontario Telephone: (705) 647-6738

Ridgetown College of Agricultural Technology, Ridgetown, Ontario N0P 2C0 Telephone: (519) 674-5456

University of Guelph, Guelph, Ontario N1G 2W1 Telephone (519) 824-4120

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Ministry of Agriculture and Food
ONTARIO
Jack Riddell Minister
Clay Switzer Deputy

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